McGraw-Hill
Publishing Company, Inc.
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POWER

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Volume 67 New York, January 3, 1928 *Number 1*

Happy New Year

AGAIN the hands of the big clock that tells the time in months and years instead of hours and days have made their round, and the new year is before us with all of its opportunities and possibilities.

What is the outlook?

For years we have run our national housekeeping without much system or correlation. Each producer produced all that he guessed he could get rid of at a profit without definite knowledge of the probable demand or the plans of others.

When a line of activity was yielding good returns, manufacturers expanded their facilities and seekers for opportunity rushed in with new mills and machinery without intelligent analysis of the relation of the installed equipment to possible demand.

With the tendency to centralization in industry statistics have become possible and usable.

When every neighborhood had its cobbler it would have been difficult or impossible to find out how many shoes were produced per year, and the information, if it were available, would have been of no use to the individual shoemaker. With an organized industry such information has become obtainable and useful.

Under the administration of Secretary Hoover, the Department of Commerce has done more for the orderly organization of our processes of production, manufacture and distribution than had been done in years before, and this, for the most part, voluntarily on the part of the industries.

Robert M. Davis, statistical advisor of the McGraw-Hill publications, sees in collective, co-operative management, guided by real information, one of the stabilizing factors of industry and trade. He summarizes the high points of the outlook as follows:

Outstanding Favorable	Outstanding Unfavorable
1. No inflation of prices.	1. Relatively unsatisfactory earnings by manufacturing companies during the last half of 1927.
2. Labor well employed.	2. A political year involving almost any political hazard.
3. No surface indications of overbuying.	3. Reparations question—Germany's payments reach their maximum next September.
4. No signs of a credit stringency.	
5. Increased purchasing power of the farmer.	
6. General construction at high levels.	
7. Record automobile construction during 1928.	
8. Federal tax reduction of one-quarter billion dollars.	

He believes that the year 1928, notwithstanding its Presidential disturbance, will be one of continued prosperity.

Let us hope so.

F. R. Low

Increased Power per Worker Presages Continued Prosperity

By Robert M. Davis
Statistical Advisor, McGraw-Hill Publishing Company

MUCH wonder has been expressed during the last two years concerning the continued prosperity of American industry. While the peoples of other countries continue to labor at low wages and the purchasing power of the public remains comparatively low, the United States has been experiencing unprecedented prosperity, and the common people have been maintaining a standard of living never before approached in the history of the World. Why has this period of prosperity continued in this country, and how long will it continue? These are two of the outstanding questions of industry and business as the new year opens.

There must be a reason, or reasons, behind this unusual condition of industrial and business affairs. We are living in a new economic era today, one in which influences are at work which have no counterpart in the eras during or before the War. Four economic factors stand out as having great influence in the maintenance of this era of prosperity. First, is the establishment and functioning of the Federal Reserve System, a system of banking and monetary control which makes difficult if not entirely impossible the great panics of the past. It has perhaps done more to smooth out the business and industrial cycles than any other factor prevalent today. There will always be the ups and downs in business. But unless the opinions of outstanding economists are in error, the intense recessions of the past are a matter of history not to be repeated, except as a result of some great and overpowering national catastrophe.

Secondly, America has become in the last few years the world's banker, the greatest creditor nation on the face of the globe. Today, we get the interest and dividends of our industrial operations, not foreigners, also a goodly portion of Europe's interest and dividends as well. The United States possesses over one-half the world's money gold, which has greatly augmented the supply of available credit. The fear of a credit stringency has been practically removed for many years to come. Thirdly, during the eight years since the close of the War this country has witnessed one of the greatest advances in social evolution ever experienced in its history. Wage earners, farmers, business and professional men have tasted of the blood of luxury, and things that were luxuries at the opening of this period have now become necessities, absolutely essential to the well-being of the common people. In 1926 the total income of the 117,000,000 persons in this nation was nearly 90 billion dollars, an increase in the annual income of 27 billion dollars since 1921. During this five-year period the average per capita income of persons gainfully occupied increased from $1,637 to $2,210. This increase in income and consequent purchasing power was not the result of an advance in the price level, for the average price of consumed goods was actually slightly less in 1926 than in 1921. And the American people, when it comes to the test, will be willing to work harder, more efficiently, and to organize better in order that these social blessings may continue to be theirs through a continued high purchasing power.

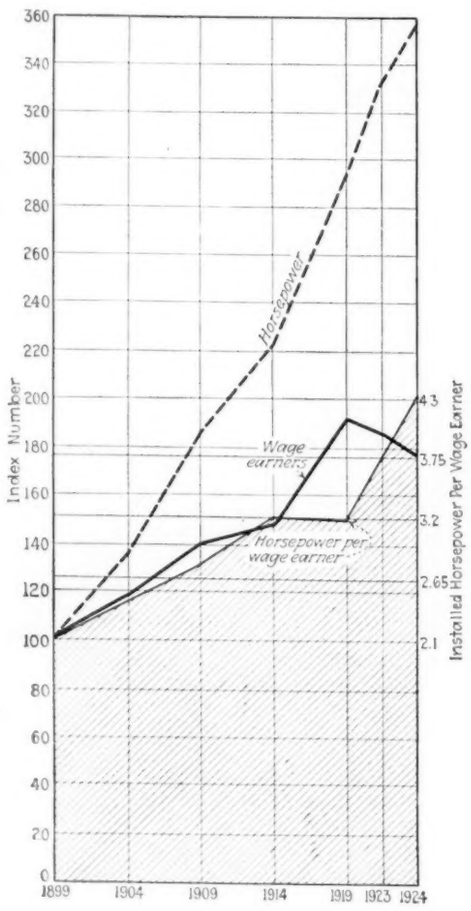


Fig. 1—Since 1919 the installed horsepower has increased 22 per cent while the wage earners have decreased 6.5 per cent

But this high purchasing power of the common people, which is absolutely essential to a continuance of our present high industrial and business activity, is largely the direct result of the fourth economic factor influence—that of increased production per wage earner. According to the last Census of Manufactures the volume of American manufactured goods in 1925 was $2\frac{3}{4}$ times that of 1899, but the number of employed was only 1.8 times as great. In other words, there has been a great increase in the output per worker; in fact, each man now produces 50 per cent more than he did in 1899. The reason for this great growth in production per worker is that we now use $3\frac{1}{2}$ times more power than we did 28 years ago. We have transferred the work of industry from the backs of men to the inanimate forces of steam, electricity and water.

This increase in the installed

primary power per wage earner has been continuous since the opening of the century. In 1899 the ratio of installed horsepower to number of wage earners in general industry stood at 2.1. During the next 15 years the power per worker was increased by 53 per cent, the ratio standing at 3.2 at the end of 1914. During the War period the ratio appears to have remained stationary, although the ratio of horsepower-hours to number of wage earners during that period was undoubtedly greater than that of any previous period in the history of the nation. Since the War the installed power per wage earner has increased 34 per cent, there being 4.3 hp. installed per worker at the close of 1925, the last year for which data are available. Since 1899, therefore, the installed power per worker has more than doubled, resulting in a volume of production per worker, as already indicated, of $2\frac{3}{4}$ times that recorded in 1899.

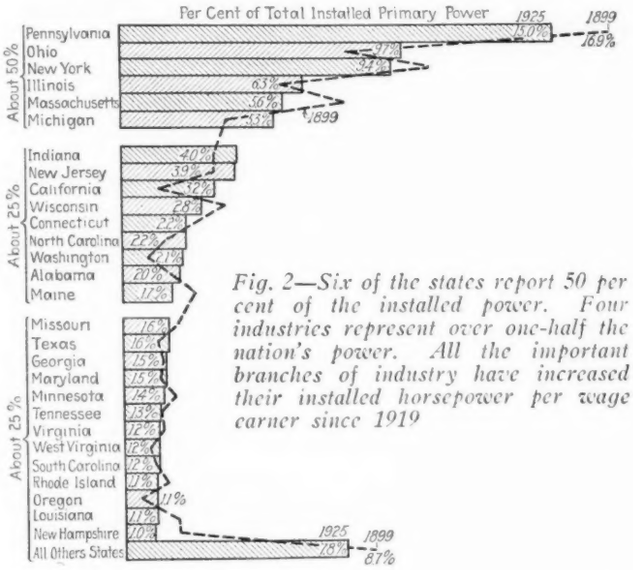


Fig. 2—Six of the states report 50 per cent of the installed power. Four industries represent over one-half the nation's power. All the important branches of industry have increased their installed horsepower per wage earner since 1919

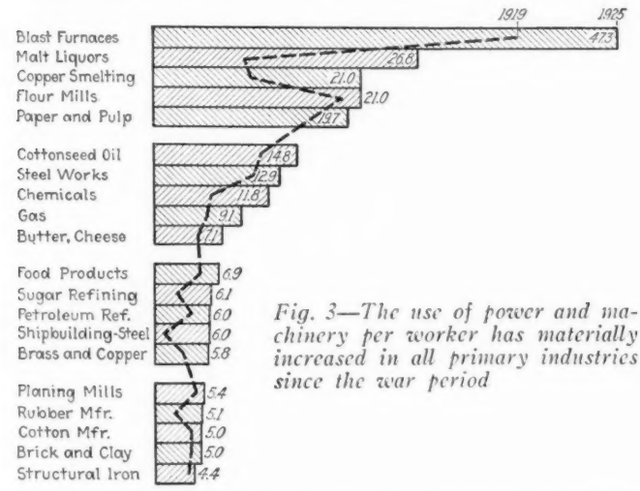


Fig. 3—The use of power and machinery per worker has materially increased in all primary industries since the war period

It is to be expected that some industries by their very nature would ultimately be able to use more power per worker than others. Such industries as blast furnaces, copper smelting and refining, flour mills, paper and pulp mills, and steel works and rolling mills, have led in this industrial evolution, the blast furnaces leading at the end of 1925 with 47.3 hp. per worker. On the other hand, there are some industries such as millinery, clothing, cigars and cigarettes, boots and shoes, and knit goods, where the process of manufacture requires relatively high hand labor and supervision per unit of commodity turned out. But all the industries without exception, even those requiring a high degree of human supervision, have increased their use of power per worker.

The direct result of this increased use of power per worker has been to release men for other productive activities, for 67 men in our factories now do the work that 100 accomplished in 1899. During this 28-year period the population has increased only 54 per cent, while the volume of production is $2\frac{3}{4}$ times as great. The answer to this seemingly impossible employment situation is that these excess men released from certain lines have gone into newly created industries, industries turning out products unknown in 1899, and yet products that have become essential to the well-being of the nation. This wider and wider use of power has resulted in more power installation and greater output per worker. This has had the effect of increasing the worker's earnings and of turning more men loose, which again calls for the creation of new industries to absorb these surplus men. There is every reason to believe that as long as this cycle—increased use of power, increased output per worker, surplus labor and new industries—is maintained, American industry as a whole will continue to operate at a high rate of activity. And American research and inventive genius, as well as the receptive nature of the American public to new commodities, gives every promise that this cycle leading to prosperity will continue to operate for some time to come.

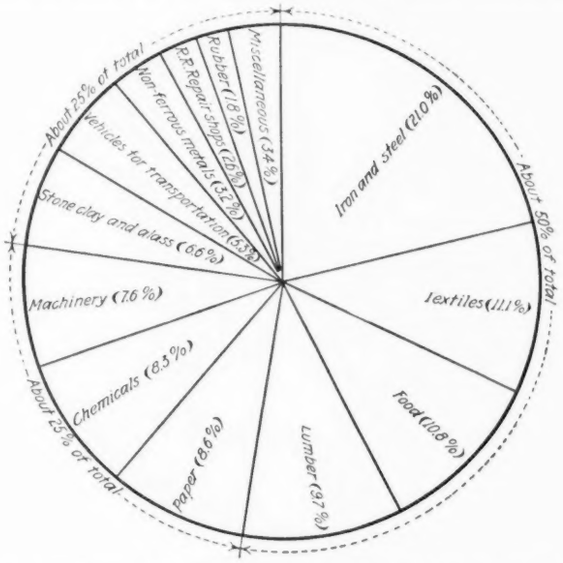


Fig. 4—Four industrial groups account for one-half of installed primary power of the nation. This is exclusive of steam supplied to process

A very significant result of this increased use of power per worker has been a materially increased production per worker. While the number of workers in manufacturing industry has been growing less and less, the volume of manufactured products has been growing greater and greater. During the last five years the production per worker in industry as a whole has increased by about 20 per cent.

Not only have great strides been made in the economics of production, but the technique of distribution has been entirely modernized. This has been accomplished through a careful study of the buying habits of the American public and general industry, the elimination of waste, both material and physical, and through rapid and cheap transportation.

These tendencies in production and distribution taken in connection with the distribution of technical knowledge through the technical press, as well as through the non-technical press, have educated the American public to a commodity demand which is without comparison in any other nation on the face of the earth. Our social psychology of today is entirely different from that of pre-war times.

But at the bottom of our present high standard of living stands power—steam, electric, hydraulic—and behind the element power is that group of engineers, chemists and scientists of which the world hears so little, but to which the world owes so much.

INSTALLED PRIMARY POWER IN MANUFACTURING PLANTS PER WAGE EARNER HAS DOUBLED SINCE 1899

	Census Years	Installed Primary Power (Hp.)	Wage Earners	Horsepower per Wage Earner
Factory, hand and neighborhood industries	1869	2,346,142	2,053,996	1.14
	1879	3,410,837	2,732,595	1.25
	1889	5,938,635	4,251,535	1.40
	1899	10,097,893	5,306,143	1.90
Factory industries only	1899	10,097,893	4,712,763	2.14
	1904	13,487,007	5,468,383	2.47
	1909	18,675,376	6,615,046	2.82
	1914	22,264,343	6,887,677	3.24
	1919	29,297,963	8,989,586	3.26
	1923	33,056,870	8,768,491	3.77
	1925	35,772,628	8,384,261	4.27
Index numbers (1899 = 100)	1899	100	100	100
	1904	134	116	115
	1909	185	140	132
	1914	222	149	152
	1919	292	193	152
	1923	330	186	176
	1925	354	178	200

INSTALLED PRIMARY POWER, 50 LEADING INDUSTRIES, 1899, 1914, 1919 AND 1925

Industries	Installed Primary Power									Installed Power per Wage Earner							
	Installed Horsepower					Rank of Industry				Horsepower per Wage Earner				Rank of Industry			
	1899	1914	1919	1925	Per Cent Increase 1919 to 1925	1899	1914	1919	1925	1899	1914	1919	1925	1899	1914	1919	1925
Agricultural implements	70,646	121,428	128,249	115,325	—10.0	18	32	39	39	1.5	2.5	2.4	4.0	21	26	28	23
Automobile, bodies, etc	3,164	173,684	544,242	1,172,013	115.5	46	22	9	7	1.4	1.4	1.6	2.8	24	37	37	31
Bakery products	22,472	107,771	165,950	227,286	36.8	37	36	30	28	0.4	0.9	1.2	1.4	41	43	41	42
Blast furnaces	497,272	1,222,273	1,618,519	1,939,000	19.7	6	5	5	5	12.7	41.6	36.8	47.3	3	1	1	
Boots and shoes	49,444	100,232	120,632	139,569	15.8	26	37	40	38	0.4	0.5	0.6	0.7	42	46	46	46
Boxes, paper	9,286	38,179	54,955	76,185	38.2	44	44	44	43	0.3	0.8	1.0	1.3	43	44	44	43
Boxes, wooden	54,724	126,805	144,048	148,729	3.3	24	28	36	37	2.5	3.3	3.4	3.7	14	18	19	26
Brass and copper products	47,257	122,700	265,688	361,242	36.2	27	31	21	20	1.7	3.0	3.5	5.8	19	20	18	15
Brick and clay products	252,502	470,758	439,194	517,204	17.6	8	8	13	15	2.4	3.7	4.2	5.0	15	17	15	19
Butter, cheese and condensed milk	88,062	130,862	168,871	201,639	19.4	15	25	29	32	6.9	5.7	4.8	7.1	4	9	13	10
Canning, fruits and vegetables	26,906	88,303	132,422	187,490	41.6	34	38	37	34	0.7	1.8	2.2	2.2	36	35	31	34
Cars, steam railroad	33,395	126,687	157,865	291,400	78.4	32	29	33	22	1.0	2.3	3.0	2.0	31	29	20	37
Chemicals	*	307,312	475,919	657,867	38.2	*	13	10	10	*	8.7	6.2	11.8	*	7	8	8
Cigars and cigarettes	4,563	13,664	24,504	24,534	0.1	45	49	49	47	...	0.1	0.2	0.3	47	50	50	47
Clothing, men's	13,347	35,664	40,577	44,749	10.4	42	45	46	44	0.1	0.2	0.2	0.3	45	48	48	48
Clothing, women's	9,962	28,396	32,622	24,316	—25.5	43	48	48	48	0.1	0.2	0.2	0.2	44	49	49	49
Coffee, spices, etc	16,270	30,869	37,101	41,184	10.8	40	47	47	45	2.6	2.8	2.9	3.9	13	22	24	24
Confectionery	19,410	55,823	83,375	100,455	20.6	39	41	41	40	0.7	1.0	1.0	1.6	37	41	43	40
Copper smelting and refining	61,630	194,980	321,610	326,509	1.5	21	20	19	21	5.4	11.0	18.5	21.0	7	5	3	3
Cotton manufacturers	795,834	1,585,953	1,863,542	2,236,363	20.0	3	4	3	3	2.6	4.0	4.2	5.0	12	15	14	18
Cottonseed oil and cake	73,071	249,781	290,636	239,005	—17.7	17	15	20	26	6.6	11.5	10.9	14.8	5	4	5	6
Dyeing and finishing textiles	69,238	130,172	160,420	252,701	57.5	20	26	32	25	2.3	2.7	2.9	3.6	16	24	23	29
Electrical machinery, etc	43,674	227,731	438,839	589,398	34.2	28	17	14	13	1.0	1.9	2.1	2.5	29	33	32	32
Flour mills and grist mills	670,719	822,384	876,405	669,900	—23.5	5	7	7	9	20.8	20.7	19.3	21.0	1	2	2	4
Food products, miscellaneous	15,485	80,022	150,230	197,903	32.0	41	40	35	33	1.9	3.9	5.0	6.9	17	16	10	11
Foundries and machine shops	381,623	964,657	1,604,211	1,424,259	—11.2	7	6	6	6	1.1	2.1	2.2	3.6	28	32	30	28
Furniture	114,568	240,665	262,703	402,519	53.2	12	16	22	18	1.3	1.9	1.9	2.2	25	34	33	35
Gas, illuminating	31,797	213,370	238,467	428,132	79.5	33	18	24	17	1.4	4.9	5.6	9.1	23	11	9	9
Glass	52,943	163,139	207,430	271,639	30.8	25	24	26	23	1.0	2.2	2.7	3.9	30	31	27	25
Hardware	22,668	53,411	67,589	98,278	45.4	36	42	43	41	0.9	1.3	1.6	1.9	33	38	36	39
Knit goods	57,346	125,842	151,601	176,630	16.5	23	30	34	35	0.7	0.8	0.9	1.0	38	45	45	45
Leather, tanning, etc	88,860	172,712	218,238	222,678	1.8	14	23	25	29	1.7	3.1	3.0	4.2	20	19	21	22
Lumber and timber products	1,375,139	2,192,542	2,358,937	2,049,500	—13.1	1	2	2	4	3.3	4.6	4.9	4.3	9	12	11	21
Malt liquors	197,901	405,884	324,431	15,259	—95.2	11	11	18	49	5.0	6.5	9.5	26.8	8	8	7	2
Millinery and lace goods	1,852	12,736	12,482	11,986	—3.7	47	50	50	50	0.1	0.3	0.3	0.2	46	47	47	50
Paper and wood pulp	762,118	1,621,154	1,851,014	2,427,010	31.2	4	3	4	2	15.4	18.3	16.3	19.7	2	3	4	5
Petroleum refining	36,127	128,468	238,906	393,753	64.8	31	27	23	19	3.0	5.1	4.1	6.0	11	10	16	13
Planing mill products	228,731	423,005	427,201	597,103	39.6	10	10	16	17	3.1	4.3	4.8	5.4	10	14	12	16
Printing, book and job	36,973	114,233	131,961	169,283	28.4	30	34	38	36	0.6	1.0	1.1	1.3	40	42	42	44
Printing, newspapers, etc	70,089	182,269	194,361	237,662	22.2	19	21	27	27	0.7	1.6	1.6	2.0	35	36	35	38
Rubber manufactures	*	199,543	429,887	597,444	38.8	*	19	15	11	*	2.7	2.7	5.1	*	23	26	17
Shipbuilding, steel	38,862	83,706	475,567	263,470	—44.6	29	39	11	24	1.3	2.5	1.4	6.0	26	27	39	14
Shipbuilding, wooden	22,935	31,627	78,144	40,000	—48.7	35	46	42	46	1.5	2.9	1.8	2.3	22	21	34	33
Silk goods	57,397	116,924	176,825	212,609	20.4	22	33	28	30	0.9	1.1	1.4	1.6	32	40	38	41
Slaughtering and meat packing	185,008	253,066	359,212	441,516	22.7	16	14	17	16	1.2	2.6	2.2	3.7	27	25	29	27
Steam-railroad shops	95,087	433,994	594,515	871,769	46.6	13	9	8	8	0.6	1.3	1.2	2.1	39	39	40	36
Steel works and rolling mills	1,100,801	2,706,553	3,820,917	4,763,533	24.5	2	1	1	1	6.0	10.9	10.2	12.9	6	6	6	7
Structural iron work	19,673	109,374	165,347	211,732	28.0	38	35	31	31	0.8	2.3	3.8	4.4	34	30	17	20
Sugar refining	*	49,666	52,541	89,098	69.4	*	43	45	42	*	4.4	2.9	6.1	*	13	22	12
Woolen and worsted goods	234,660	381,220	468,480	570,295	21.4	9	12	12	14	1.9	2.4	2.8	3.5	18	28	25	30
All industries, United States	10,097,893	22,437,072	29,504,792	35,772,628	21.2	...	...	...	...	2.1	3.2	3.2	4.3	...	...	...	...

*Figures not available.

LOOKING FORWARD *in the Power Field*

Some trends that will influence business in 1928 as seen by leaders in certain branches of the field . . .

Increase in Central Station Capacity

EVIDENCE of continuing normal prosperity is afforded by the projects for increases in electrical plants announced for 1928; in fact, the estimated expenditures for 1928 fully equal the actual expenditures in 1927. These projects utilize refinements and extend applications of the notable developments of recent years. In some cases, particularly for the size of units, new records will be attained.

Conspicuous among the projects to be undertaken are the increases in the plants of the great Metropolitan systems. In New York the Hell Gate, East River and Hudson Avenue stations will be augmented by new units which will equal or exceed in size the great machines already installed in these plants. The two 94,000-kva. units proposed for the Hell Gate station are the largest single units ever built for 1,800 r.p.m.; while the 160,000-kw. unit for the East River station is the largest single generator unit as yet constructed. The Brooklyn Edison Company has under way a 110,000-kw. unit; the Detroit Edison Company will bring in 100,000 kw. at Delray No. 3; and Crawford station in Chicago will add 100,000 kw.

The first of the 40,000-kva. hydro units of the Conowingo plant is expected for service in the spring of 1928. These waterwheel generators exceed in diameter any other machines except the largest steam-driven generators of 20 years ago.

Among the great interconnected systems the Ohio Power Company is proceeding with the installation, at Philo, Ohio, of a 165,000-kw., triple-unit turbine-generator set. The installation should be complete by the end of 1928. Work will continue upon the first 208,000-kw. triple unit of the million-kilowatt State Line station on Lake Michigan, east of Chicago. In the Alabama Power Company 108,000 hp. will go in at Lock 18 and 41,500 hp. at the Tallapoosa River Plant. The Carolina Power & Light Company will complete 83,000 hp. in 1928 and 90,000 hp. in 1929, of an ultimate development of 245,000 hp. on the Yadkin and Pigeon Rivers.

In California, at the Long Beach No. 3 station of the Southern California Edison Company, the first 100,000-kw. unit of an ultimate development of 800,000 kw. is scheduled for February, 1928, and during the year 112,000 hp. additional will be brought in on the Big Creek development.

Among other extended developments now in definite form is the program of the Northern States Power Company beginning in 1928 and extending to 1931, involving an estimated expenditure for plant of $20,000,000; the plan of the Connecticut Light & Power Company, which will bring in 32,000 hp. initially on a five-million-dollar program, and the Chelan development of the Washington Water Power Company, which will bring in 32,000 hp. of the 128,000 hp. ultimate. The Cascade Power Company will begin in 1928 upon a program extending to 1931 for the development of a total of 75,000 horsepower.

On account of the magnitude of the electrical development no attempt has been made to give a complete tabulation. The preceding is, however, indicative of the construction proposed for 1928 and also that which is already under way. It is estimated that about 2,000,000 additional kilowatts will go into service in 1928. About one-fourth of this amount will be hydro and the remaining three-fourths will be steam.

H. S. BENNION, Director of Engineering,
National Electric Light Association.

Excess Capacity Hampers Boiler Industry

THERE have appeared in many publications views by various authorities as to the outlook for the coming year, and it apparently is generally conceded that business conditions will not be good nor bad, although the general tendency points downward. This is reflected in the reports to the Department of Commerce by our Association as to the sale of boilers, which shows a downward curve in the volume of business being booked, although the steel heating boiler industry unquestionably will show advances

The boiler industry in particular is in the position of several other industries in that the productive capacity

is somewhat in excess of a normal demand. As a result the industry as a whole cannot be looked upon as being in a satisfactory state, although for the volume of business being done, if a reasonable manufacturer's profit were obtained, the industry undoubtedly would feel itself in a satisfactory condition. As pertinently put in a recent article appearing in *Nation's Business*, conditions today might well be termed as "Profitless Prosperity."

This is substantiated by the startling facts recently put out by the Department of Commerce, which showed that approximately 42 per cent of the corporations reporting to the Treasury Department for the years 1920-25 inclusive, report a loss.

The productive capacity of our industry being somewhat in excess of the demand, as referred to above, was not by any means due entirely to over-expansion, but can be attributed to a great extent to the fact that today boilers are operated at somewhat higher ratings and higher efficiencies than a few years ago. A normal boiler installation today would probably be for one-half the rated capacity to take care of the demand that a few years ago would have been put in, owing to the higher ratings and high efficiencies at which boilers are now being operated. This, of course, reflects directly upon the amount of business placed with the boiler industry.

The country in general is conceded to be in a prosperous condition and we must look forward optimistically to the future in our industry, in order to participate in and enjoy the country's prosperity.

STARR H. BARNUM, President,
American Boiler Manufacturers Assn.

Normal Year Faces Stoker Manufacturers

DURING the last few years the stoker manufacturers have, by intensive research and development, so improved their apparatus from the viewpoint of efficiency, reliability, capacity and economy of maintenance, that they are offering a product economically competitive and at least for certain purposes, superior to other methods of fuel burning.

The public utilities of the country are continually revamping and extending their generating stations, and in this program stokers have played and will continue to play an important part.

The varied industrials, in their attempts to meet competition by reducing manufacturing costs, are intelligently investigating boiler-room economies, byproduct steam applications, and industrial furnace firing, and these investigations will result in a continued increasing demand for stokers.

Owing to the increasing insistence for smoke abatement and the almost universal popular demand for labor eliminating devices, a considerable market is being created for small stokers for apartment and office buildings.

During the last year a modern stoker installation equipped with clinker grinders and supplied with preheated air was placed in service on a 15,000-ton Lake steamer; the acknowledged success of this installation will undoubtedly lead to a broadening of the marine market for stokers.

Money rates are low, crops are good, inventories are low, exports are relatively high, and purchasers should have little or no trouble in financing their constructive requirements; so the stoker manufacturers look forward to 1928 as a year of normal business.

R. B. MILDON, President,
Stoker Manufacturers Association.

New Factors Helpful to Power Transmission Business

WHEN such leaders as Mr. Charles Schwab, in his recent comment in Philadelphia, upon receiving an honorary degree from the University of Pennsylvania, all economists and our Washington spokesmen forecast good business for 1928, the power transmission manufacturers may know that they have an opportunity to get their share.

Thanks to the interest and support given the Power Transmission Association, these industries enter the new year in the best technical position of recent years. The teamwork displayed, together with the stimulation of power uses to proper consideration of power transmission problems and most efficient and economical distribution of power, should give these manufacturers a decided advantage in 1928 over any recent year.

The usual competitive factors in the various groupings will, of course, obtain. They face the same basic problem of all manufacturers, one of narrowing margins of profits.

It is hoped the present Congress may grant the United States Department of Commerce the necessary funds to survey this situation. When Chairman Green of the House Ways and Means Committee says that 40 per cent of all manufacturers have made no profits in recent years and over 50 per cent of the rest made less than $25,000 a year, there surely is need for such a study. Secretary Hoover and his associates have pointed out and helped relieve many losses and wastes in industry and commerce. May the Department be able to help manufacturers meet and avoid such losses in 1928 and subsequent years.

The belt transmission manufacturers are not looking forward to a much larger volume of business in 1928 than they enjoyed in 1927. In the leather belting field, there obtains the added difficulty of advancing the price of the finished product to correspond with the advance of price in raw material, and they will do well if they maintain even the same volume of business in 1928 in tonnage as they did in 1927. They may swap more dollars but at less profit. It will require increased sales effort and careful management.

The chain drive branch of the power transmission field is exceptionally optimistic as for the outlook of business in 1928. The increasing use of chain drives in the automotive field on such machines as spray car-washers, car-lifting apparatus and shop-equipment tools seems to have opened up a new field in that branch of the power transmission industry. The tendency seems to be more individual and group-drive units which are growing all the time and not as many inquiries are being received for large power drives as formerly.

So-called "hand-to-mouth" buying or small inventories of power transmission equipment, supplies and acces-

sories on the part of power users, should do much to offset any possible psychological effect of a Presidential year and to keep up a good rate of renewal purchases in 1928. The trend of construction of industrial plants since 1920 has been fairly even and is prophesied for 1928 to be nearly as large as in 1927 Therefore, it should keep up a good demand for power transmission equipment, accessories and supplies for new installations or alterations in existing plants. According to Power Transmission Association surveys, the yearly volume of power transmission equipment accessories and supplies runs over a hundred million dollars, two-thirds of which represents renewal purchases which should go along in 1928 on about the same basis, and one-third for new installations which certainly will not drop off more than 5 or 10 per cent in 1928.

W. S. Hays, Executive Secretary,
Power Transmission Society.

The Oil Engine Situation

U. S. CENSUS Reports made public this year have surprised many persons who were unaware of the dominating position the stationary oil engine has attained in the field of moderate-sized prime movers. In the size range of 100 to 499 rated horsepower, 873 oil engines were manufactured in 1925.

One of the criticisms formerly made of the Diesel engine, was that it was an engine of quite limited power. This no longer applies, and at present engines can be obtained to meet any requirement. Engines are in service in this country up to a size of 4,000 hp. During the last year a 4,000-hp. Diesel was installed by the Tucson Gas & Electric Company, Tucson, Ariz. Other Diesels of large capacity include the 3,750-hp. Diesels installed in the Panama Canal Zone, and the 2,250-hp. units put into operation by the Commerce Royalty & Mining Company, Miami, Okla., and by the town of Ponca City, Okla. Other large engines placed in operation include a number of 3,000-hp. units purchased by the Shipping Board for marine purposes.

The drift is decidedly toward larger engines, and builders of solid injection engines have proved that even this design is not limited to small powers. Engines of 1,500 hp. have been built during the year, and tests prove the reliability of this design up to even 300 hp. per cylinder.

An examination of conditions existing during the past year indicates that engines of under 300 hp. no longer make up the majority of horsepower sold. This is due primarily to the advent of motor-driven pumping and drilling rigs in the oil fields, which curtailed the use of oil engines where electrical rates were cut to absurd figures. In addition, during the last year there has been less activity in irrigation, cotton-ginning and other industries that make an extensive use of oil engines.

The same condition has not been experienced in the case of large units. Many municipal electrical light plants have found it necessary to increase capacity, and this has led to the installation of Diesel engines of 500 hp. and larger. The same condition exists in privately owned light plants. There is a drift toward the general use of oil engines in connection with long transmission lines. In Texas several of the holding companies during the last year installed Diesels at stragetic points along their lines.

The purchase of oil engines for oil pipe-line pumping stations has not been so brisk as in former years. This is traceable to two factors. In the first place the country is fairly well saturated with oil pipe lines, and besides motor-driven pumps are being installed in several fields where the pools appear to be short-lived.

Marine developments have been attractive inasmuch as there have been a number of engines purchased for tugs, dredges, ferryboats and yachts. The Shipping Board has also purchased twelve engines for Diesel-electric propulsion of three ships.

There is a less attractive side to the picture, which merits serious study by all who are interested in cheap power. Facilities for producing oil engines have been increased faster than the market has been educated to appreciate them; that is, demand has not kept pace with possible supply. In the quest for business there has been a marked tendency for some manufacturers to reduce prices below the point where a profit can be made. In addition many concessions as to terms, accessories, etc., have been granted.

At present it must be conceded that not many builders are making a profit. This is restricting much needful development and experimental work. In the opinion of many active in the industry, the engine builders must organize with a view of installing a uniform cost accounting system as well as standardizing on engine sizes, list of accessories and like points. There is a tremendous waste of sales effort. Sales are becoming fixed on the basis of the installment plan of payment. A standardized form of contract similar to that used in the sale of automobiles could be worked out. In addition there is a need for united efforts to combat actively the mass of propaganda now being issued to the disadvantage of the oil engine builders.

Edgar J. Kates, Chairman,
Oil and Gas Power Division A.S.M.E.

Economic Trends Point to Still Greater Use of Power

AT THE turn of the year the country continues actively to increase the amount of power employed in industry—a movement that has shown greater and greater acceleration for many years and which is of the greatest importance to our economic welfare. Foreign manufacturers are frequently bewildered by the fact that in the United States we pay perhaps four times as much as the German wage, three times the British wage and ten or twenty times the Oriental wage, notwithstanding which we are able to export manufactured goods, successfully marketing them all over the world. Many foreign missions have recently visited this country in order to find an explanation of this situation, and have found that we are employing perhaps three times as much power per workman as do the British, four times as much as the Germans and ten or twenty times as much as the Oriental.

The last few years have witnessed startling increases in the productivity of this country, as pointed out by the National Industrial Conference Board, for in our industries in 1925, sixty-seven workers produced as much as

had been produced by one hundred men as recently as 1899, and this in spite of the shorter hours now prevailing. All branches of American industry, however, have not shared alike in this progress. The detailed figures suggest that there is a relationship between the increased consumption of power per worker and the increased production per worker. In 1925 it required less than thirty-five workers to produce as many automobiles as could have been produced by one hundred workers in 1914, but during this same interval the horsepower employed was multiplied nearly seven times. The prosperity of the individual American is closely related to this increase in per capita use of power.

There are also some significant changes in the power industry, because American shops are depending more and more upon purchased power and upon electrical energy, while during recent years there has been relatively little increase in total capacity of isolated power plants depending upon steam engines, oil engines and the like. At the present time the trend toward electrification is quite pronounced.

Present trends suggest that there will be an even larger employment of power per workman in American industries, particularly electrical power and hydro-electric power where available.

Also during recent years there has been a startling increase in the efficiency with which fuels have been utilized. Power plants are probably consuming one-third less per horsepower than was the case only a few years ago. Present trend suggests further progress along these lines.

All these factors represent substantial progress in directions of great importance. The power and power equipment industries are making great contributions to the general welfare through this advancement.

W. H. RASTALL,
Chief, Industrial Machinery Div.,
Department of Commerce.

Industrial Construction as an Index

IMPORTANT industrial construction totalled $289,000,000 in 1927, compared with $291,000,000 in 1926. Of this a varying, but appreciable, portion covers power equipment and various plant services. This is a difference of less than one per cent. The table compares activities in the various industries. Before studying the figures, it should be understood clearly that they reflect plant expansion and not production. They represent increased productive capacity that will be employed at some later date, and do not therefore reflect current production. Production may actually decline during a period of active plant construction. Conversely, as also will be shown, production may increase while the volume of building is falling off.

The first division in the table covers central station power plants and shows an apparent decrease from 1926 of $29,000,000. It must be remembered, however, that the 1926 total includes appropriations for the great hydro-electric power plant of the Susquehanna Power Co. at Conowingo, Md. The number of utilities power-plant projects awarded in 1927 is 103, against 86 let during the preceding year.

Declines in both number and value of projects occurred in the following industries: Machinery and equipment, printing and binding, foundries, lumber and woodworking mills, and cement and quarry products. It should be noted here that in two of these industries (lumber and cement) production is well ahead of the 1926 schedule. Also interesting, although production is under 1926 in the steel and automotive industries, construction contracts have been let in excess of those in 1926.

NUMBER AND VALUE OF INDUSTRIAL BUILDING CONTRACTS IN FIRST ELEVEN MONTHS

Millions of Dollars (000 omitted in value)

	1927	1926
Public Utilities		
Value	$40,921	$86,922
Number of contracts	103	86
Chemical Process		
Value	17,484	19,172
Number of contracts	93	92
Food Products		
Value	21,634	19,713
Number of contracts	153	146
Automotive		
Value	29,868	27,755
Number of contracts	196	190
Machinery and equipment		
Value	22,804	58,956
Number of contracts	153	323
Textiles and clothing		
Value	51,357	12,005
Number of contracts	84	108
Printing and binding		
Value	3,881	7,287
Number of contracts	35	45
Steel mills		
Value	11,652	6,180
Number of contracts	25	15
Cement and quarry products		
Value	6,802	18,572
Number of contracts	18	28
Foundries		
Value	1,633	3,442
Number of contracts	12	43
Refrigeration and cold storage		
Value	6,328	5,242
Number of contracts	48	39
Lumber and woodworking		
Value	2,353	6,864
Number of contracts	21	45
Warehouses		
Value	10,499	10,221
Number of contracts	65	43
Unclassified		
Value	40,671	17,110
Number of contracts	274	158
Total		
Value	$267,878	$299,501
Number of contracts	1,280	1,362

All this new industrial building construction of course calls for new power machinery and allied equipment. In addition, there is the $145,000,000 worth of heating, ventilating and power equipment needed for the $1,594,000,000 worth of new commercial and institutional buildings of $150,000 and more contracted for in 1927 and, of course, not included in the figures just discussed.

Distribution of 1927 industrial building over the country has been remarkably like that of 1926, except for heavy increases in the South and the Pacific Coast. The $35,000,000 increase in the South is accounted for by the award in December of contract for a rayon plant in Tennessee to cost $37,500,000. The increase on the Coast has been consistent throughout the year.

Will the pace be maintained in 1928? There can be no definite answer to this question, and a guess has no specific value. A significant fact, however, is that whereas the value of industrial building contracts awarded in the second half of 1926 was 22 per cent less than that of the first half, the value of these contracts let in the second half of 1927 has been 92 per cent higher than that of the first half. There is thus a momentum that should carry into 1928.

A. W. WELCH, Manager,
Business News Department,
McGraw-Hill Publishing Co., Inc.

The Business Trend Since 1921*

By Dr. Julius Klein

Director, Bureau of Foreign and Domestic Commerce, Department of Commerce

AMERICAN business is justly proud of the fact that it has left as monuments of its progress since 1921 a long succession of junk heaps of discarded processes, antiquated ideas and obsolete policies. There have been, it is true, some tragic instances of those who have clung too long to revered and once profitable practices and have consequently seen the march of progress roll far ahead of them.

There can be no doubt that our recent commercial progress and present momentum have been due largely to the disposal of the incumbrances that were discarded along the way as business climbed out of the post-war pit. Not the least among these abandoned "antiques" have been the old devotion to excessive business secrecy, the fear of losing some small temporary advantage by adopting the "new fangled notions" of simplified practice; the suspicion that statistics and efficiency programs are "academic" and the contempt for associated effort.

But by this indorsement of the abandonment of time-worn incumbrances, I would not for a moment imply that all consideration of the past is futile. In fact, our business community is deserving of ample credit for its increasing interest in retrospection. The best evidence of this is the prevalence of the study of trends and curves of the trade experiences of recent years. Index numbers and carefully plotted charts are no longer academic mysteries.

The curves for the majority of business indicators have traced an encouraging upward path since 1921. There have been no serious downward dips in spite of frequent prophecies, especially during the last three years. This sounds like the steady progress of sustained prosperity, and indeed it has been that, even though the number of commercial failures in 1926 exceeded those of 1921 by nearly 10 per cent. Using 1919 as a basic one hundred, the production index for manufacturing in 1921 was 81 and by 1926 it had risen to 128.

During the early months of 1927 industrial production continued at or near the high level of the preceding year. Then came the usual summer seasonal slump, but the recovery in the autumn was not as marked as had been hoped. However, many individual industries have operated at a higher level than a year ago, and at the present time there are distinct evidences of an upward trend.

One factor in this remarkable record should be borne in mind: A busy business is not necessarily a prosperous one, at least for the employer, owner and those dependent upon them in financial and other interested circles. High gross receipts and high profits are not always synonymous.

I ventured the opinion some time ago that in several of our older industrial establishments there are still too many "Aunt Sarahs." She was the good lady, you will recall, who inherited a shoe factory and insisted that the plant continue to turn out high button shoes because "Uncle Ezra" had made it pay with that line in the seventies. *Nearly 44 per cent of the machinery in one important industrial group is more than ten years old, which in these days of strenuous competition and constant change threatens to get pretty close to the border line of industrial senility.*

It is evident that some of the lessons of mass production are being applied with increasing intensity to mass distribution. The chain store system has notably expanded.

The electrical industry affords an illustration of the striking changes since the War. The great increases in combustion engines both for transportation and industrial uses has stimulated the electrical industry to much keener efforts toward better merchandising, one notable feature of which has been a remarkable development in aggressive advertising with evidently satisfactory results. Likewise the development of certain new lines has served as a further stabilizer of the industry. Incidentally, in this field of electrical development our telephone wire mileage has increased from about eighteen million in 1915 to approximately fifty-one million in 1926. These figures alone indicate the astounding advance that has been made in the facilities for speeding up business; time is money and the telephone industry has done its part during these recent years in making a vital contribution toward the saving of invaluable hours and days in commercial negotiations.

There were widespread prophecies immediately after the War that we would soon be overwhelmed in every one of our overseas markets under an avalanche of returning

MODERN business, and especially American business, was never more dynamic and volatile than it is today. One of the outstanding reasons for such successes as have been achieved during the last six years by American industry and commerce is the highly effective contact that has been maintained with a constantly changing front, the constant check that has been kept upon the operations of those persistent "foes," waste and inefficiency, by the vigilant services of our trade papers, and trade associations and the improvement in governmental fact-finding agencies.

*Note—From a talk delivered to the Associated Business Paper Editors at Chicago in October, amplified by the latest Department of Commerce figures released Dec. 30.

European competition. The experience of these years has completely belied such gloomy forecasts. Even at the bottom of the pit in the year 1922, our exports were greater than before the War both in value and volume, having averaged about $2,130,000,000 a year during 1910-14 and exceeding $3,830,000,000 in 1922. Our exporters have certainly climbed with surprising speed, having increased their overseas sales by more than one billion dollars during the last five years, and this in the face of most harassing competition in the shape of depreciated European currency and labor costs, wholesale export subsidizing by competitor governments, and serious demoralization in many otherwise attractive markets through depressions in their home industries.

Foreign Trade as a Stabilizer

The value of foreign trade as an effective even though relatively moderate stabilizer of our general business position was never more clearly demonstrated than in 1927. Exports will exceed $4,925,000,000 and attain the substantial increase of 18 per cent in volume and 2½ per cent in value over 1926, the discrepancy being due to declining prices. This gratifying result represents a steady, normal rate of advance and was achieved in considerable measure by the efforts of several industries which, having suffered a slackening of domestic trade below the record figures of 1926, due in part to price declines, found a most helpful corrective through the more intensive exploitation of overseas markets.

Our exports of finished manufactures have increased in each of the last five years, and in 1927 were over 50 per cent higher in value than in 1922.

There has been an increase of about 10 per cent in the value of our exports of semi-manufactures during the past year as a result of larger sales of copper and lumber abroad.

Turning to the regional distribution of our trade in 1927, as compared with 1926, the United States has exported more merchandise to all continents except Oceania. There has been a particularly large gain, amounting to about 14 per cent, in our exports to Canada, based on 10 months' figures, and that country advanced to first place in our trade, supplanting the United Kingdom, which has held that position throughout most of the history of the United States.

Exports to Europe have shown a considerable growth during the last year, 3 per cent as compared with 1926, in consequence of the continued economic recovery of that continent. This trade expansion, however, has been only partly reflected in the values reported, on account of the fact that prices of several of the most important commodities purchased from the United States by European nations have averaged substantially lower than a year earlier.

Shipments to South America have been slightly larger in 1927, reaching the total value of about $450,000,000. This is about twice the value of the trade in 1922. Our largest customer in South America, Argentina, increased its purchases by about 14 per cent in the first 10 months of 1927, as compared with the corresponding period of 1926.

It might be of interest to review the part which the Department of Commerce has had in keeping industry and trade advised of the constantly changing situations which were reacting upon their positions. Obviously, the chief problem when we found ourselves at the bottom of the 1921 pit, was the disposal of the incumbrances of wasteful production practices, unemployed workers, inefficient operations, inadequate information as to markets and innumerable other hindrances. The Unemployment Conference of 1921 under the chairmanship of Secretary Hoover developed a definite program of staggered, off-season undertakings in public works, which contributed materially toward the gradual elimination of some two million unemployed.

Simultaneously, investigations of engineering committees on efficiency in production revealed a startlingly high percentage of sheer waste, the net total of which was estimated to be not less than six billion dollars in our manufacturing industry, and probably much more. With this definite objective in mind, a comprehensive campaign for waste elimination was launched through hundreds of collaborating trade associations and trade papers. The Department has maintained contact with this situation through more than seventy advisory committees which have been functioning as boards of strategy upon the problems of their respective trades in this campaign.

This machinery, which has been quietly and altogether voluntarily but effectively collaborating with the Department, has insured a unity of method and action throughout industry and trade which has been widely commented upon by visiting foreign industrialists, governmental observers and others, who have come to study the economic recovery of this country since 1921.

Results Achieved Represent Many Times the Expenditure

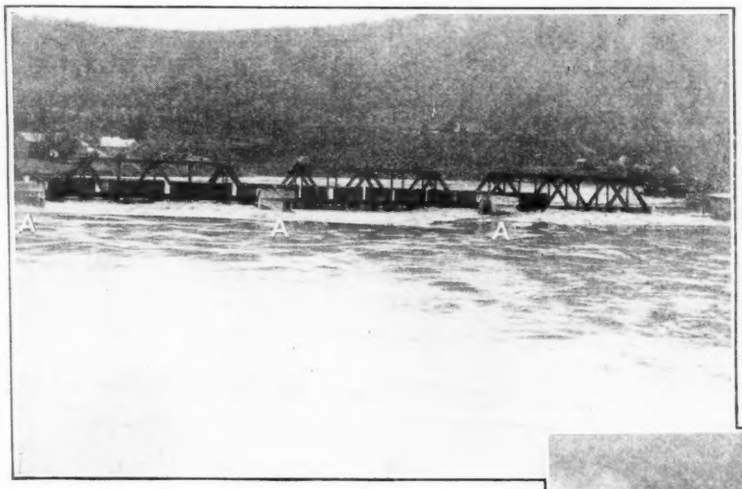
The files of the Department contain voluntary indications from industry which show that each year the value of the actual results achieved by these trade promotive services, not simply in new business but also in the prevention of wasteful effort, exceeds many times the entire appropriation of the Department. In fact, for this year the compilation of these dollars-and-cents results will probably fall not far short of fifteen times the amount expended by the Department in all of its services. And this represents, of course, only one small phase of the Department's work.

The files of the Bureau contain data on some 300,000 potential foreign agents for American exporters and upon several hundred desirable foreign legal connections, which according to frequent testimony have been responsible for substantial savings to our overseas trading operations. A conspicuous feature of the Bureau's work has been a campaign for the elimination of waste and carelessness in the protection of American patents and trade-marks abroad, in compliance with the requirements of foreign tariff administration and consular regulations.

The domestic commerce work of the organization is of more recent origin, but it has already developed a wide field of usefulness through its studies of retail merchandising, its analysis of marketing conditions and buying power in different areas of the United States through its market surveys, two of which, those on New England and the Southeastern states, are now in press. These are really attempts to appraise the potentialities of certain markets with a view toward laying a complete statistical groundwork for more intelligent selling in those territories.

POWERGRAPHS

The Unexpected in Water-Power Development



What happened a few weeks ago at Bellows Falls, Vermont, at the new plant of the New England Power Association, is a good example of what can occur in water-power developments. At A on the left can be seen the tops of the piers for the roller gates to be placed on top of the dam, the water in the river having reached up on the railway bridge. Although the cofferdams were submerged and the construction equipment washed away very little damage was done to the permanent structures.

On the right is a scene at the upper end of the power canal, near the dam shown above. The flood came into the canal over the cofferdam and down to the power house shown below.

On the left is the power house and forebay. At the right in this picture the water appears to be going over a dam. This is the spillway at the end of the power house and can be seen in the picture below.

On the right, the spillway at the end of the power house was partly completed when the flood occurred and is shown with about twelve feet of water flowing over it. This plant, when completed, will contain three 20,000-hp. units to operate under a 60-ft. head and will replace about 75 small water-wheels used in a number of plants.

Combustion Control Formulas

IV—Application of formulas to test data

By E. A. UEHLING
M. E., Dr. of Engineering

IN ARTICLE III of this series, published in the Dec. 27, 1927, issue of *Power*, various equations were developed for determining the heat losses in the flue gas leaving the boiler per pound carbon unit of fuel. To illustrate the application of these formulas to boiler test data and to allow comparison of the results with the results calculated by using the more complicated and standard equations, data have been selected from boiler tests at the Delray plant of the Detroit Edison Company, run under the supervision of Dr. J. S. Jacobus. Test No. 5 represents the lowest, No. 6 medium, and No. 18 the highest rate of driving at which tests were made and are respectively 94, 150.7 and 195.7 per cent of rating.

The ultimate analysis of the coal used in these tests together with the weights of the constituents per pound carbon unit are given in Table I. In Table II are given

TABLE I—ULTIMATE ANALYSIS (DRY COAL)

Test No.	C	H	S	O	N	Ash	Moisture	B.t.u.
5	76.94	5.35	1.38	8.22	1.11	7.00	1.80	13,896
6	79.41	5.60	1.14	7.14	1.18	5.53	2.22	14,037
18	76.59	5.26	1.09	6.22	1.06	9.78	2.17	13,680

TABLE II—OBSERVED TEST DATA

Test No.	Per Cent CO_2	Per Cent CO	Gas Temp.	Air Temp.	Carbon in Per Cent	Weighed Refuse per Lb. Coal
5	14.4	0.35	483	73	31.6	6.89
6	14.7	0.31	662	79	26.7	6.13
18	14.2	0.16	694	73	23.2	9.81

the observed data, and Table V shows the heat balance results as reported by Doctor Jacobus and as calculated from the formulas.

In test No. 5 (see Table II) the CO_2 averaged 14.4 per cent. The gas left the boiler at an average temperature $T = 483$ deg., and the average air temperature t was 73 deg. Inserting these values in Formula 1, we have, $0.24 + \frac{58.46}{14.4} \times (483 - 73) = 1{,}763$ B.t.u. of sensible heat lost in the dry gas. Inserting the value of CO and CO_2 into Formula 2, we have $10{,}160 \times \frac{0.35 + 14.4}{0.35}$ = 241 B.t.u. loss due to CO.

The coal as fired contained 1.8 per cent of moisture,

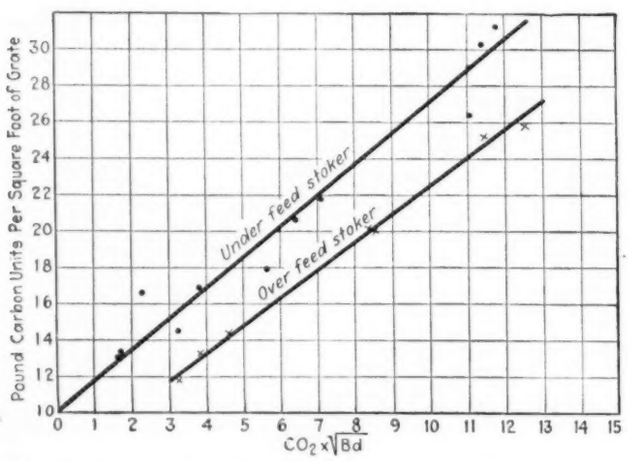


Fig. 1—Curve showing relation of rate of combustion to combustion index

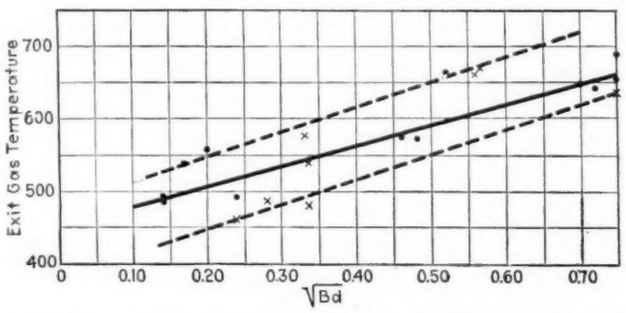


Fig. 2—Relation of square root of boiler draft and exit gas temperature

which is 0.018 lb. per pound of coal, and it contained 76.9 per cent of carbon, which is 0.769 lb. per pound of coal; we have, then, $\frac{0.018}{0.769} = 0.0234$ lb. of H_2O or $\frac{0.0234}{9} = 0.0026$ lb. of hydrogen per pound carbon unit. From Table III we find the dry coal contained 0.069 lb. of hydrogen, therefore H_t in the coal as fired in test No. 5 contains $0.069 + 0.0026 = 0.0716$ lb. of total hydrogen (H_t) per pound carbon unit. Inserting

TABLE III—ULTIMATE ANALYSIS—POUND PER POUND CARBON UNIT (DEG.)

Test No.	C	H	S	O	N	Weighed Refuse	Moisture	Weight of P. C. Unit
5	1.00	0.069	0.018	0.108	0.014	0.089	0.024	1.298
6	1.00	0.071	0.014	0.090	0.015	0.077	0.029	1.260
18	1.00	0.069	0.014	0.081	0.014	0.128	0.030	1.30

this value of H_t together with the values of T and t into Formula 3 we have, $0.0176 \times [(10460 - 9 \times 73) + (4.3 \times (483 - 212)] = 765$ B.t.u. of heat lost in the wet gas.

Air saturated at 73 deg. contains 1.62 per cent, or 0.0162 lb., of water vapor per pound. The average degree of saturation during the test was 62.4 per cent. Therefore, the weight of water, A_v, per pound of air supplied was $0.0162 \times 0.624 = 0.0101$ lb. Inserting this

value of A_v together with the values of CO_2, T and t into Formula 4, we have $0.0101 \times \left(\frac{117}{14.4}\right) \times 483 - 73 = 34$ B.t.u. of heat loss due to humidity of the air.

The weighted refuse lost through the grate for test No. 5 was 0.089 lb. per pound carbon unit. The refuse contained 31.6 per cent carbon, or $0.089 \times 0.316 = 0.0283$ lb. of carbon per pound carbon unit. Therefore the refuse carried to waste $0.0283 \times 14{,}600 = 413$ B.t.u. per pound carbon unit burned.

Similar calculation from the observed data of tests 6 and 18 gave the heat losses shown in Table IV.

TABLE IV—HEAT LOSSES IN B.T.U.*

Test No.		Test 5 B.t.u.	Test 6 B.t.u.	Test 18 B.t.u.
1	Sensible heat in dry gas	1,763	2,460	2,708
2	Heat loss due to CO	241	210	113
3	Heat loss due to moisture and H in fuel	799	880	870
4	Heat loss due to humidity in air	34	64	47
5	Heat loss due to carbon in ash	413	299	434
	Total	3,265	3,913	4,172

* Editor's Note—Items 1 and 2 of Table IV are the heat losses in B.t.u. per pound of carbon burned, while items 3, 4 and 5 are in B.t.u. per pound carbon unit fired to the boiler.

The itemized heat losses of these tests were reported by Dr. Jacobus in per cent of the heat per pound of fuel. In order to make the results given in Table V comparable with the reported results they must also be reduced to a per cent basis.

The standard heating value of the pound carbon unit of fuel is based on the assumption that fuel is completely burned to CO_2 and H_2O. Therefore, the heat represented by the CO and the carbon in the ash must be added to the standard heating value of the coal actually burned. From Table V we find the heat loss due to CO and carbon in the ash for test five to be respectively 241 and 400 B.t.u. Adding these two items to the standard heating value we have $17{,}900 + 241 + 400 = 18{,}541$ B.t.u. heat input per pound carbon unit of coal burned. In the same way the corrected heat input for tests Nos. 6 and 18 are found to be respectively $17{,}900 + 210 + 299 = 18{,}509$ B.t.u. and $17{,}900 + 113 + 432 = 18{,}445$ B.t.u. Multiplying the heat loss items given in Table IV by 100 and dividing by the corresponding heat input, we get the heat loss items in per cent of the heat in the coal fired. These results are given in Table V under the columns headed by the letter U. In the same table under column J are given the results as computed by Doctor Jacobus.

TABLE V—HEAT BALANCE—PER CENT*

	Heat Loss Items	Test No. 5 J	Test No. 5 U	Test No. 6 J	Test No. 6 U	Test No. 18 J	Test No. 18 U
1	Sensible heat in dry gas	9.11	9.50	13.17	13.26	14.34	14.47
2	Heat due to CO	1.29	1.30	1.16	1.14	0.63	.60
3	Heat loss due to moisture and H in fuel	4.45	4.31	4.95	4.78	4.85	4.66
4	Heat loss due to humidity in air	0.20	0.18	0.36	0.35	0.27	0.26
5	Heat loss due to carbon in ash	2.29	2.23	1.71	1.62	2.42	2.34
	Total loss	17.34	17.45	21.35	21.15	22.51	22.61
	Difference	0.11		0.2		0.1	

* Editor's Note—Although the method used to calculate the per cent heat losses is not correct, the results obtained are not greatly in error. To be strictly accurate the B.t.u. heat loss of items 1 and 2, Table IV, should be multiplied by 1 minus the pounds of carbon in the refuse per pound carbon unit, and all of heat loss items divided by the standard pound carbon heating value of 17,900 B.t.u.

Table V shows a close agreement between the per cent heat losses as given in the report of the tests and as calculated by the heat loss formulas. The differences are so small that for practical control purposes they may be neglected.

The tests employed to illustrate the reliability of the heat loss formulas were made on two boilers of the inclined-tube type rated at 2,365 hp. One of the boilers was equipped with an underfeed stoker and the other with an overfeed stoker. In all other respects the settings were practically the same. The curves in Fig. 1, plotted from data taken from these tests, show the relation of $CO_2 \times \sqrt{Bd}$ to the rate of combustion in pound carbon units burned per square foot of grate per hour. The rate of combustion increases with fair regularity as the product of $CO_2 \times \sqrt{Bd}$ increases. Because of the greater grate area (446 sq.ft.) of the overfeed stoker, against 406 sq.ft. of the underfeed stoker, the rate of combustion per square foot of the former is less than that of the latter, for the same value of $CO_2 \times \sqrt{Bd}$.

It is evident that the relation of $CO_2 \times \sqrt{Bd}$ to rate of combustion will vary with type and size of the boiler as well as the construction of the setting and arrangement of baffling. Therefore, to become practically applicable it must be established experimentally for each boiler.

The variation in temperature at which the gas leaves any given boiler is due to many causes, chief of which is the rate of flow of gas through the boiler, of which $\sqrt{Bd}$ is an index. The curves in Fig. 2 show the relation between the $\sqrt{Bd}$ and the corresponding exit gas temperatures. The temperatures recorded in the majority of the tests lie on or very close to a straight ascending line, which is the line of the most probable normal temperature of the escaping gas for these boilers. The gas temperatures of four of the tests follow closely on a line below and six on a line above the line of normal temperature. The reason for this deviation from the apparent normal temperature line is not divulged by the records of the tests. This, however, does not contradict the fact that a practically true relation exists between the $\sqrt{Bd}$ and the temperature at which the gas leaves the boiler. It is

HEAT LOSS FORMULAS

Formula 1: $\left(0.24 + \frac{58.46}{CO_2}\right) \times (T - t) =$ B.t.u. of sensible heat in dry gas per pound carbon unit.

Formula 2: $10{,}160 \times \frac{CO}{CO + CO_2} =$ B.t.u. heat loss per pound carbon heat unit due to incomplete combustion.

Formula 3: $H_t\ [(10{,}640 - 9t + 4.3 \times (T - 212)] =$ B.t.u. heat loss due to hydrogen in the fuel per pound carbon unit.

Formula 4: $Av \times \left(\frac{117}{CO_2}\right) \times (T - t) =$ B.t.u. heat loss due to humidity in the air per pound carbon unit.

Formula 5: $\sqrt{Bd} \times CO_2 =$ index of the rate of combustion.

Formula 6: $\sqrt{Bd} =$ index of the normal exit gas temperature.

self-evident that the true normal temperature relation must be established for every size and type of boiler and arrangement of baffling. The usefulness of the line of normal temperature as a check on the factors that affect absorbtion efficiency, such as cleanliness of heating surface both inside and out, condition of baffling, and air leakage, is evident.

It is evident that the per cent of CO_2 and CO, the temperature of the gas on leaving the boiler and the square root of the boiler draft are the fundamental data required for intelligent and effective control of boiler operation. How the formulas so far established and discussed can be applied to the foregoing data with the least expenditure of time and trouble will be shown in the succeeding articles.

What Do You Know?

By L. H. Morrison

The answers are on page 25

OCCASIONALLY, we hear of some eminent engineer being called as a witness in a lawsuit. This man may get high fees, but it is worth the money to be forced to withstand the volley of unanswerable questions put by the opposing counsel. If the flustered expert leaves the stand with a vow of "Never Again," he cannot be greatly blamed. How much easier would it be if he were allowed to do his own cross-examining! The ten questions below will enable any engineer to steal away and discover how much of an expert he really is before giving his evidence. The editor is more liberal than is the opposition counsel in that a mere "yes" or "no" answer is not demanded; in fact, the editor cannot answer them without some elaboration and qualification.

Ques. 1—Would it make any difference in the compressor performance if the condenser of an ammonia refrigerating system were set on top of a 70-ft. building, in place of on the compressor-room floor?

Ques. 2—A siphon is used to deliver water from one tank to another set below the first, and whose water level is 15 ft. below the level in the first tank. If the rim of the first tank over which the siphon pipe curves, is five feet above the surface of the water in this tank, what pressure exists in the siphon at its crest, which is at the tank rim?

Ques. 3—Why are not the cylinders of steam engines fitted with removable liners as are oil-engine cylinders?

Ques. 4—Is sand in condensing water an advantage or a disadvantage?

Ques. 5—If combustion is completed in the furnace, what disadvantage is there in permitting air to leak through the setting into the second or third pass of a boiler?

Ques. 6—In the field of heating and ventilating what is meant by effective temperature?

Ques. 7—Where are superheaters located in horizontal fire-tube boilers?

Ques. 8—If a centrifugal pump and a motor are placed on a one-piece cast-iron base, why is a flexible coupling used generally?

Ques. 9—Can you obtain more steam with a pressure drop of 25 lb. from a tank holding 100 cu.ft. of water at 358 deg. F., the saturation temperature for 150 lb. abs., or from the same tank if filled with steam at 150 lb. abs.?

Ques. 10—How high should the oil be maintained in an elevator worm-gear case?

Bronze-Welded Joints in Cast Iron Pipe

The Linde Air Products Company and the United States Cast Iron Pipe Company have made a joint investigation and tests of bronze-welded joints in full size cast iron pipes, the results of which are summarized as follows:

The bronze-welded collar joint for cast-iron pipe is inefficient.

The weakness of the joint and the characteristic failure that occurs in the cast iron next to the bronze collar is not, as has sometimes been contended, due to shrinkage of the bronze collar, structural change, or any detrimental effect on the cast iron from heat or the bronze-welding process. The weakness is in mechanical design and is the result of a very high stress concentration adjacent to the collar.

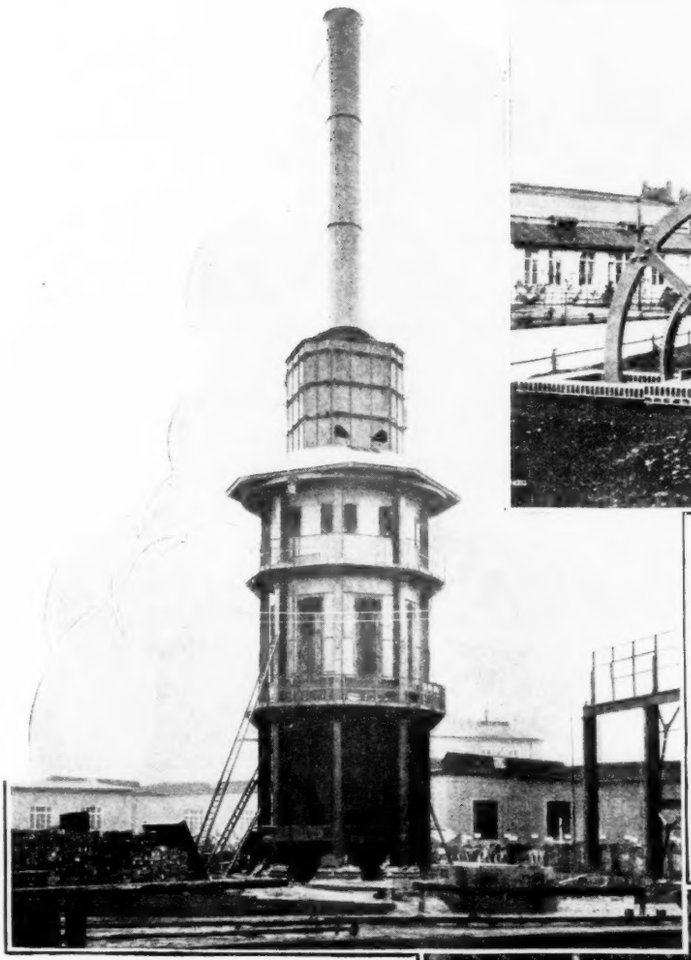
The bronze-welded vee joint is from 50 per cent to 100 per cent stronger than the collar joint. The strength of the vee joint, although not exactly equal to that of the pipe, approximates it. Searing or annealing the machined bevel is necessary to insure a strong positive union between the bronze and cast iron.

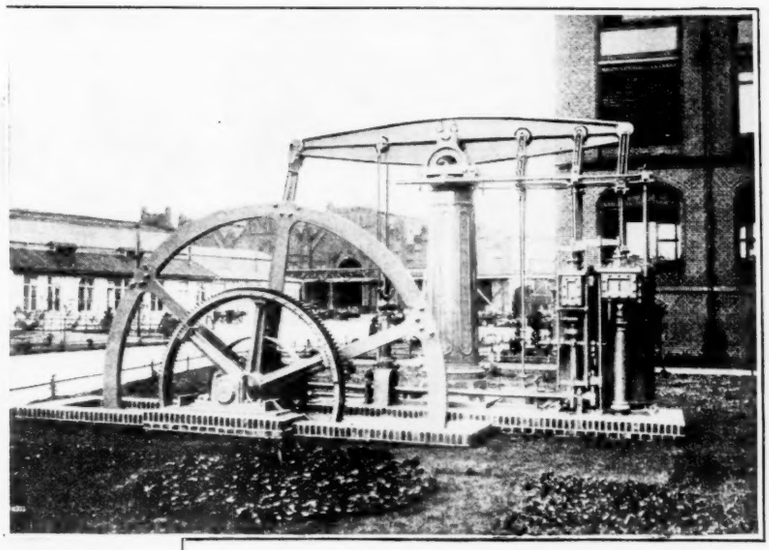
The shear-vee joint, by adding a shear area to the strong vee joint, develops practically the full strength of the pipe

The vee-type joints, in addition to being stronger, require less materials, are more easily and quickly made and are hence cheaper than the collar joint. They compare favorably in cost with any of the common mechanical joints in use which do not have the absolutely leak-proof, non-deteriorating qualities offered by the bronze-welded joint for cast-iron pipe.

Under ordinary conditions, the use of these joints, combined with reasonable care and thought in laying and placing expansion joints, guarantees the elimination of failures in a bronze-welded cast-iron pipe line.

POWERGRAPHS



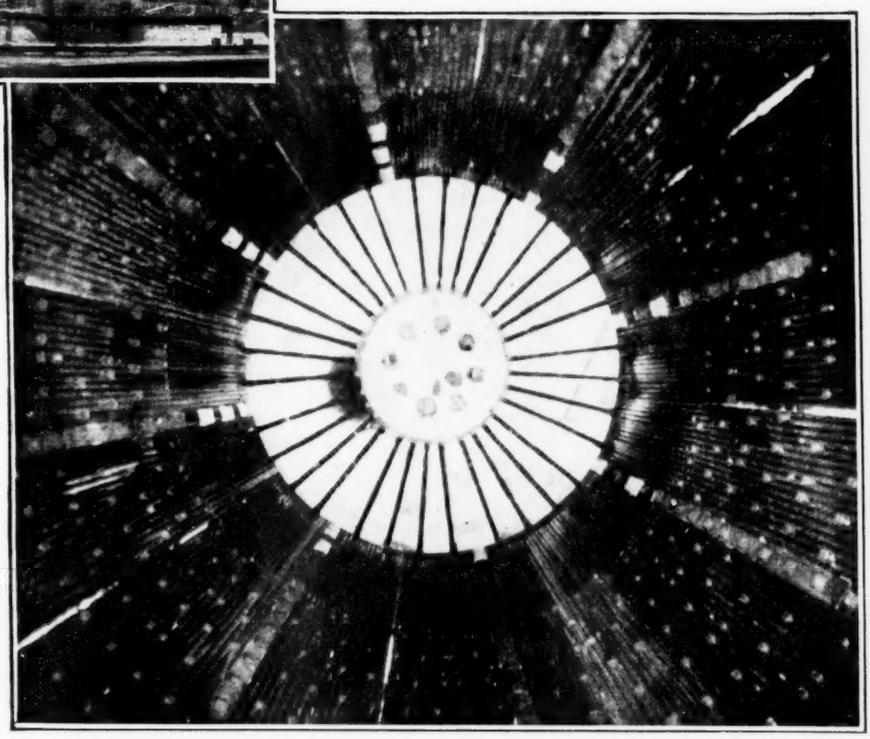


Steam Engines as Memorials

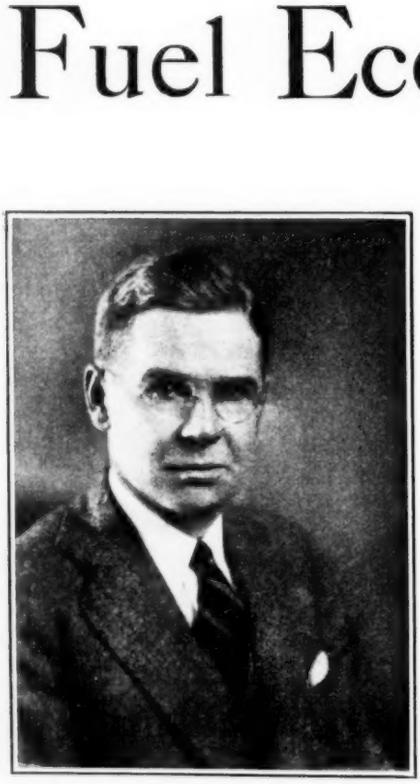
The faithful servants of yesterday are deserving of being preserved as memorials of the past at one of the big factories in the suburbs of Berlin. Here is shown one of the machines thus honored. It was in service 53 years.

Above: Exterior view of Benson boiler as installed at Siemens-Schuckertwerke, Germany. It operates at 2,600 lb. per sq.in. pressure, a total steam temperature of 885 deg. F. and has a steaming capacity of 60,000 lb. of steam per hour

Right: Looking up into the combustion chamber of the Benson boiler. The powdered coal burners are at the top center and the walls consist of vertical tubes



Fuel Economy *Affected by* Management Interest



By Howard W. Morgan
Sales Engineer, Pittsburgh Coal Company

THE author classifies boiler plants in three groups: Those plants in which the management takes a keen interest in the operation and knows accurately the cost of producing steam; those in which the management takes a more or less casual interest and knows approximately the relation from month to month of the amount of coal burned to the products of the factory; those in which the management takes practically no interest and keeps no records at all of coal consumption except the tons purchased

NO DOUBT the efficiency with which any operation in a manufacturing process is performed is directly proportional to the interest that the management takes in that operation. From a large number of combustion tests conducted on the boilers in industrial power plants, I know that it is true of the production of steam. In the manufacture of many commodities the cost of fuel is a very small part of the total cost of the finished product. I have been told that, in the case of automobiles (not considering the fuel used in the manufacture of the steel), the fuel cost is only a few cents per car. In the manufacture of tires and other rubber goods the fuel cost bulks larger; in paper it is one of the major cost items.

Naturally, one would expect to find the most interest in fuel economy in the industries in which the ratio of fuel cost to total cost of production is the highest, and in a general way this is true. There are, however, so many exceptions to any general relationship that may exist between the ratio of fuel cost to total cost and the efficiency with which the fuel is burned, and the available statistics on fuel economy in various industries are so meager, that I doubt that anything more than a general trend toward higher efficiency of fuel burning with increased importance of fuel cost can be established.

A more definite relationship could probably be shown between the efficiency with which fuel is burned and the base cost of the fuel. When a man pays $6 a ton for his coal, he will treat it with more respect than when he pays $2 a ton, but it cannot be argued from this that all boilers in Canada are operated more efficiently than any boilers in Pittsburgh.

There is no such thing as a typical industrial boiler plant as to either its equipment or its operation. They cannot even be scientifically classified into typical groups. However, from the data available on combustion tests conducted on a large number of these boilers, I believe they can be roughly classified into at least three general groups according to the amount of interest taken by the management in their operation. It may be of some interest to attempt such a rough classification and see what may be found. The word "typical," as used in this discussion, must not be taken too literally, as there probably is no such thing as a typical combination of equipment in any classification of boiler rooms that can be devised.

The general classes of boiler plants may be described as follows:

Class A. Those plants in which the management takes a keen interest in the operation and knows accurately the cost of producing steam.

Class B. Those in which the management takes a more or less casual interest and knows approximately the relation from month to month of the amount of coal burned to the products of the factory.

Class C. Those in which the management takes practically no interest and keeps no records at all of coal consumption except the tons purchased.

In a typical Class A plant are found water-tube boilers

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and mechanical stokers. The coal fed the stoker hoppers is either weighed on a traveling weigh larry or is measured by a meter installed in the coal chute. In the larger plants it may be weighed on an automatic scale in connection with the conveyor system. Sometimes the coal is weighed on platform scales before being conveyed to the storage bins above the stoker hoppers, and at regular intervals the coal in the bins is leveled off and the consumption for the period is estimated partly by volumetric calibration of what is left.

Equipment Found in Class A Plant

Each boiler is equipped with an integrating flow meter from which the daily output of steam is obtained. This meter also shows the rating at which the boilers are operating at any instant.

If the flow meters are of the type showing the output of steam only, each boiler will also be equipped with a CO_2 recorder and a recording thermometer showing the temperature of gases leaving the boilers. Sometimes a single instrument combines the information obtained from these three.

A feed-water treatment plant is installed to remove scale-forming impurities. When practically all the water leaving the boilers as steam is returned as condensate or when unusually pure water is available, the treatment plant may be missing, but it is the typical plant that is being considering, so it had better be included in the picture. There will also be a feed-water heater to bring the temperature up to 200 to 212 deg. In connection with the feed-water system there will be a V-notch or Venturi meter as a check against the steam-flow meters and the blowdown water.

On the front of each boiler there will be a set of draft gages showing the draft over the fire at the uptake and, if it is a forced-draft plant, the windbox pressure. Each boiler will be equipped with mechanical soot blowers, and these will be used at least once each day. When high-volatile coals are burned, the soot will be blown three times a day.

If there are two or more boilers on the line continuously, some form of damper-control apparatus will be found, or perhaps a complete combustion-control system regulating coal feed, windbox pressure and uptake dampers. If it is a one-boiler plant, there may be hand control, but you will find that the control on the uptake damper is brought to the front of the boiler where it is convenient for the fireman to use it.

Examination of the brickwork will show it to be free from cracks or other openings through which air can enter. Steam lines and valves will be tight. The boiler room will be clean and shipshape. The fireman will appear to have an easy job.

The steam-flow meters will show that the boilers on the line are operating at from 150 to 200 per cent of their rated capacity. There will be at least one spare unit undergoing cleaning and repairs.

In the typical Class B plant, will also be found water-tube boilers and mechanical stokers, although in this class many fire-tube boilers also exist, either hand-fired or stokered. The coal fed to the stokers is not weighed, but from current purchases and periodic checks of coal in storage an attempt is made to compare coal consumption per unit of factory output from month to month or season to season.

There are no steam-flow meters or boiler feed-water meters. There is no feed-water treatment plant but a compound is used. There is a feed-water heater.

Draft gages of the oil type are on the front of the boiler, but they are not reading correctly, being short of oil.

A damper-control apparatus operates the uptake damper. There are no recording instruments except a steam-pressure recorder.

Soot blowers are installed and are said to be used once a day, but nobody knows except the fireman on the night shift, as it is the practice to blow soot at night.

The boiler room is neat and clean. The fireman does not seem to be overworked.

Equipment Found in Class C Plant

In Class C it is rather difficult to say whether the typical plant has water- or fire-tube boilers or whether they are equipped with stokers or hand-fired. One is just as likely to find water-tube boilers with mechanical stokers as not. The basic equipment, therefore, does not account for the different conditions encountered in Class C plants.

These plants are characterized by a complete absence of recording instruments, weighing or metering devices and control apparatus.

The water treatment, if any, consists of dosing with a compound.

The feed-water heater is too small and the feed-water temperature is only about 125 deg. Exhaust steam that could be used to heat feed water, goes to the atmosphere, and hot water is lost to the sewer.

There are no mechanical soot blowers. Soot is blown with a hand lance once a week.

All the boilers are on the line steadily for seven months of the year except for an occasional week-end.

No attempt is made to regulate the dampers, but they are left wide open at all times.

The boiler room is dark, mussy and cluttered up with fire tools. The fireman is very busy. He has to work his fires to hold steam, and he has to fight clinker. He will tell you that the boss is always crabbing about how much coal he is using, but won't buy anything to help him save it. He will tell of about a half-dozen things he ought to have but can't get.

While it is more than likely that the Class C plant will be burning a poor quality of coal because nobody takes much interest and the purchasing agent buys on price only, for the sake of simplifying our calculation assume that all three plants burn the same quality of coal, a steam slack from the Pittsburgh district having a proximate analysis shown in Table I.

TABLE I—PROXIMATE COAL ANALYSIS

	Per Cent
Moisture	1.5
Volatile matter	35.5
Fixed carbon	53.0
Ash	10.0
B.t.u. (as fired)	13,200

Approximate Heat Balance

From the data in Table II can be calculated an approximate heat balance. In the case of the Class A plant the heat absorbed by the boiler—that is, the over-all efficiency—can be obtained directly from the coal and water weights, and the radiation and unaccounted-for losses can be obtained by subtracting the sum of all the other items in the heat balance from 100 per cent. In

the case of the Class B and Class C plants, the radiation and unaccounted-for losses would have to be estimated, but probably this can be done within 1 or 2 per cent by taking the figure obtained from the Class A plant as a basis to guide us, and estimating the losses from the general conditions and rating at which the boilers are operated. The heat balance would look about as follows:

TABLE II—OBSERVED DATA

	Class A Plant	Class B Plant	Class C Plant
Flue gas temperature, deg. F	500	575	650
Average CO_2 per cent	12.0	8.5	7.0
Unburned carbon in ash, per cent	18	25	35
Feed water temperature, deg. F	212	190	160

TABLE III—HEAT BALANCE BASED ON COAL AS FIRED

	Class A Plant	Class B Plant	Class C Plant
Heat absorbed by boiler, per cent	77.8	69.0	58.5
Dry flue-gas loss, per cent	11.4	18.7	25.9
Heat lost due to moisture and hydrogen in coal, per cent	4.4	4.6	4.7
Loss due to unburned carbon in ash, per cent	2.4	3.7	5.9
Radiation and unaccounted for losses, per cent.	4.0	5.0	6.0

Valuation of Losses

In figuring what the inefficiency of Class B and Class C plants is costing the company in unnecessary fuel losses, consideration can be taken of only the actual cost of producing steam in the boiler room. If one were to go out into the factory, there would, no doubt be found the same sort of conditions in the use of steam that have been found in its production; that is, the Class A plant would use the steam economically throughout the plant, the Class B plant would waste more or less, and the Class C plant would waste a large part of the steam manufactured. This would also be noticeable in the boiler room itself, for in the Class C plant piping uncovered, and steam hissing from the joints in the main header and on the auxiliary lines is common. To get an idea of what the variations in over-all efficiency in the production of steam already shown mean in dollars to the company, consider one plant from each group and assume that they each require the same amount of steam per year, that they operate their boilers twenty-four hours per day with fairly uniform loads averaging 27,000 lb. of steam per hour, and that the delivered price of the coal is $4 a ton. To make this steam, the Class A plant burns 10,000 tons of coal per year, the Class B plant will burn 11,280 tons and the Class C plant 13,100 tons, for the same period. The annual cost to produce this amount of steam is for the Class A plant, $40,000; for the Class B plant, $45,120; and for the Class C plant, $52,400.

In describing the typical plant, it will be remembered that there was no essential difference in the basic equipment. This means that there is no inherent reason why the Class C plant cannot get into the Class B plant category, nor is there any reason why the Class B plant cannot reduce its coal cost to that of the Class A plant. In the case of the Class C plant some money would have to be spent for soot blowers and automatic control equipment in addition to expenditures for recording instruments and meters. In the case of the Class B plant the only expenditure necessary is for some recording instruments and meters and possibly feed-water treatment. In addition to this the management will have to take an interest in the plant and develop a means of keeping daily records so that some good will be obtained from the data provided by the instruments. Without going into detailed costs of the equipment that would be required to make the savings that are shown, it is fairly safe to say that in the average Class B and Class C plant, the equipment necessary would pay for itself in one year or less as well as for the time of the man who is delegated to keep the boiler-room records.

My experience leads me to believe that Class A plants are comparatively rare. The majority of industrial boiler rooms will probably fall into the Class B group. Many of them are burning much larger tonnages of coal than in the typical example that is shown. In spite of all that has been written on waste of coal and means of preventing it, there are still a larger number of Class C plants scattered over the country and not a few Class D and E which are beyond description. Any company that knows exactly what results it is obtaining from its boiler room, need not worry about coal cost, but the company that does not know may be pretty sure an investigation would show the plant in with Class B or Class C and that they are losing money at about the rate shown.

Who Is an Employee?

By Arthur L. H. Street

A BASKET factory's boilers were found to be defective and one Wells, a boilermaker and general repair man, was employed to make the necessary repairs. He had been at work on the job for three or four weeks when he was accidentally injured in the course of the employment, through a fall of a water tank.

Question arose as to whether or not he was an "employee," within the meaning of the Texas Workmen's Compensation Act. Wells claimed that he was, while the employer's insurance company said that he was an independent contractor and therefore not covered.

The Texas Court of Civil Appeals decided (Lumberman's Reciprocal Association vs. Wells, 297 South Western Reporter, 884) that Wells was an employee and therefore entitled to an award under the Compensation Act. The decision was influenced by the fact that he was instructed by the factory's superintendent what repairs to make and was under that official's supervision while doing the work, although he kept his own time and was not told *how* to make the repairs. The court said:

"Certainly keeping machinery it uses in repair is within the 'usual course of business' of a manufacturing concern. It could not very well carry on its business without doing that. In many instances repairs necessary are simple and can be and are made by operatives of machines used. It would be unreasonable, it seems to us, to say that such an operative, while engaged in repairing a machine he was using, ceased to be employed in the 'usual course' of his employer's business. And yet we see no reason why that should not be said if it is true that repairing machinery of a manufacturing plant is not in the 'usual course' of business of such a concern."

A Survey by the House Heating Committee of the American Gas Association shows that at the end of the last heating season there was a total of 118,167 installations for house heating with gas. Of these 22,972 were steam, hot water and vapor systems, and 95,373 were warm-air installations. During the year 22,203.4 million cubic feet of gas were burned at a cost of over $15,000,000.

Waste Fuel and Power Interchange Cheapens Steel Mill Power

By Gordon Fox

Electrical Engineer, Freyn Engineering Company, Chicago, Ill.

Average output ratio of 85 per cent maintained in 10,000-kw. plant by power interchange arrangement. Built at cost approximating $100 per kilowatt. Fuel, operating and maintenance expense less than 0.3 cent per kilowatt-hour

ONE of the factors leading to the construction of Betty furnace of the Central Alloy Steel Corporation was the saving in cost of electric power that might be realized through utilization of blast-furnace gas. Initially, it was determined to supply the entire Massillon, Ohio, works with electric service from the new power house, discontinuing the connection with the local public utility. However, a satisfactory plan for power interchange was evolved whereby the steel company receives supplementary power from the utility as required and delivers its surplus to the utility at times when there is an excess of power above plant demands available from blast-furnace gas. This arrangement is such that it is not necessary for the steel company to carry reserve electrical capacity. The power plant is laid out with a view to possible full power development at a later date, some of the equipment having been provided already on that scale when the power interchange arrangement with the utility was perfected. The power plant is also a service plant in that it provides air for blowing the blast furnace and steam for both the blast furnace and coke ovens (which were built subsequent to the blast furnace) and is tied in with the water supply to these plants.

At present the electric power development involves a single 10,000-kw. turbine generator, which uses all the blast-furnace gas at periods of maximum availability. At periods of lesser gas supply the deficiency is made up from supplementary fuels, so that the power installation may be fully utilized and a high output ratio obtained, resulting in low fixed charges on output.

Coke breeze and pulverized coal are the supplementary

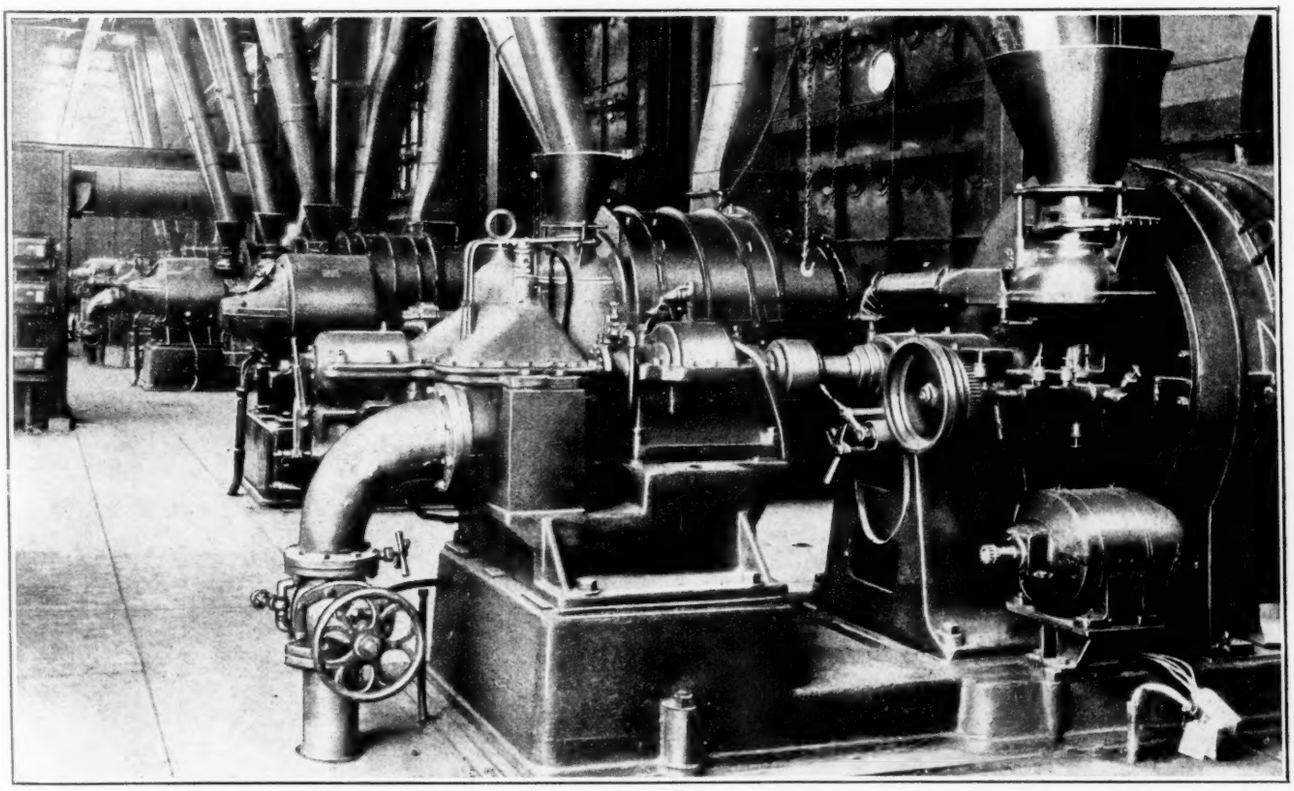

Fig. 1—Unit pulverizers at front of boilers

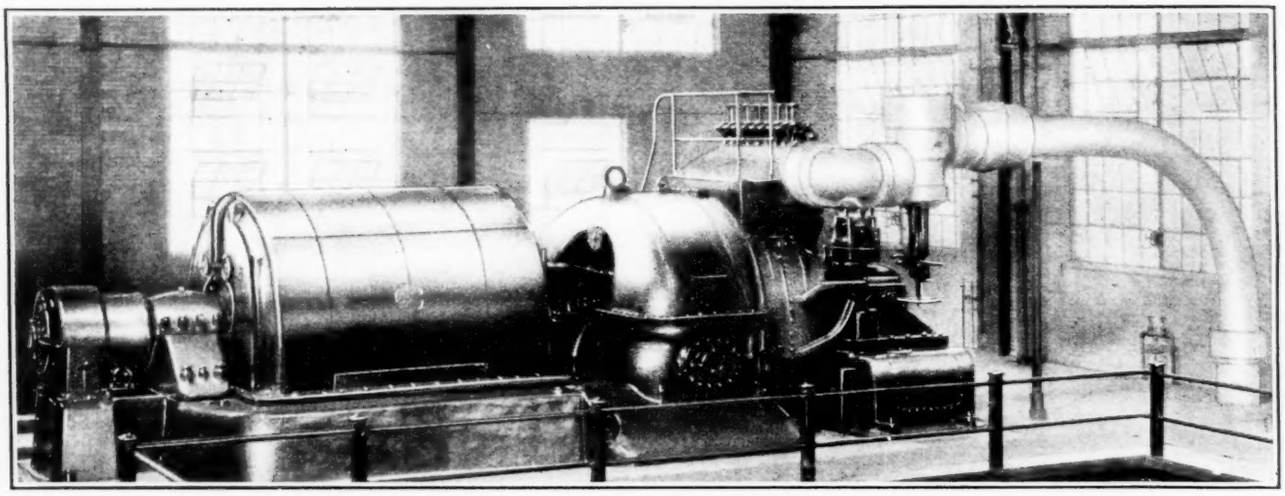

Fig. 2—Turbine generator of 10,000 kw. capacity

fuels. The firing of coal in pulverized form was determined upon because of its flexibility, low stand-by losses, high efficiency and particularly because it enables the use of available cheaper coals not best suited for stoker firing. After an extended investigation unit-type pulverizers were selected and the choice has proved most satisfactory.

In the boiler plant are six boilers, each having 8,900 sq.ft. of heating surface and equipped with an integral economizer of 4,600 sq.ft. Five of the boilers burn either blast-furnace gas or pulverized coal, and one boiler is provided with a stoker upon which either coke breeze or coal may be burned. The boiler settings have a useful furnace volume of about 0.75 cu.ft. per sq.ft. of heating surface.

Pulverized coal is supplied to the five boilers by eight impact-type unit pulverizers, some of which are cross-connected. Six of these mills are driven by motors and two by steam turbines. This arrangement affords flexibility and reliability together with a minimum of equipment for maximum utilization.

Four water-cooled coal burners serve each boiler, the coal being fired vertically downward. About 30 ft. below the burners are the water screens, which have been placed low enough to avoid interference with the combustion of blast-furnace gas. Primary air for combustion of the coal is drawn through external ports into hollow side-wall blocks, where it is preheated to about 300 deg. F. before passing through the pulverizers and burners with the coal. Part of this primary air is introduced at the coal feeder of each pulverizer, where it absorbs a material part of the moisture in the coal. Secondary air is drawn into the boiler through ports in the front wall of the setting.

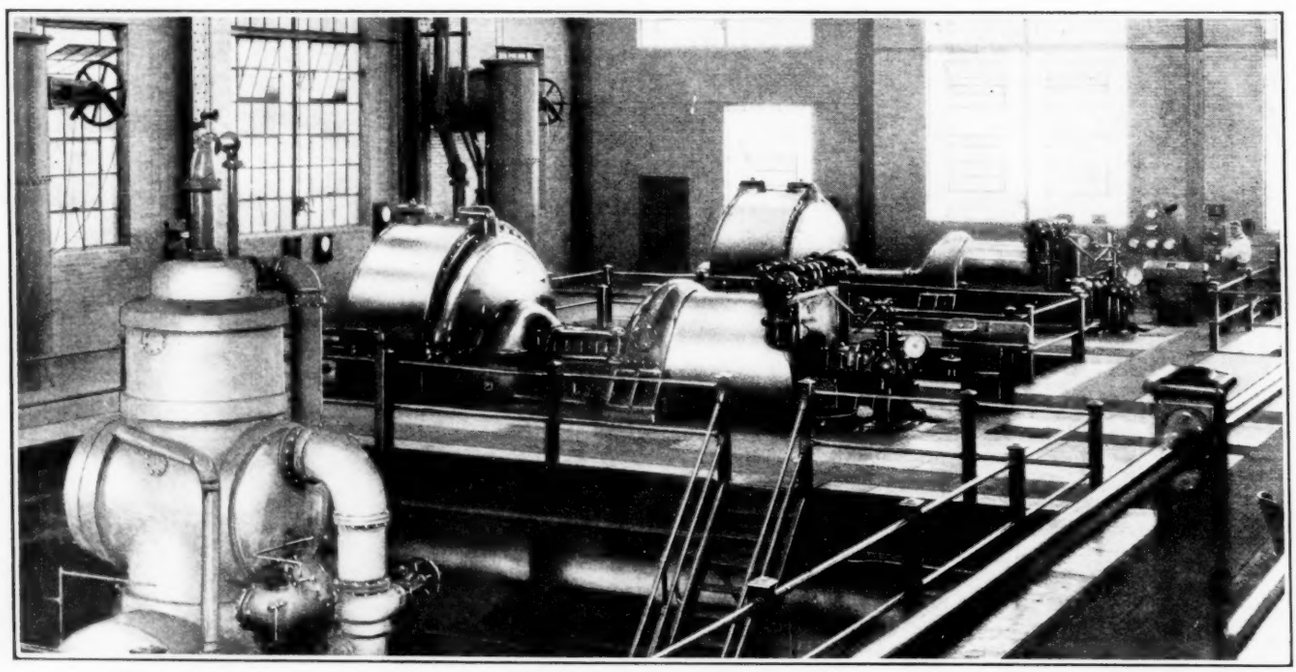

Fig. 3—Blower end of turbine room

Each of five boilers is equipped with two pressure-type gas burners located at the rear of the boiler and firing horizontally forward through an oven. Preheated air, taken through the hollow side walls of the boiler, is supplied to these burners by either one of two common fans. One of these fans is turbine driven, while the other, more commonly used, is motor driven.

Natural draft is provided for all boilers by a stack said to be the highest east of the Mississippi River. Being 365 ft. high and 18 ft. 9 in. in diameter at the top, it provides sufficient draft through the three boiler passes and the economizer to develop 250 per cent rating on gas and 300 per cent rating on coal.

A comprehensive electrical combustion control system, responsive to steam pressure and steam flow, is one of the features of the boiler plant. A master steam regulator actuated from the main steam pressure, controls a motor-operated rheostat which varies the fields of the damper, secondary air and fuel compensator generators. These three generators, together with the generator supplying power to the pulverizer feeder motors, are combined with a turbine and a motor arranged for dual drive, to comprise a six-unit motor-generator set which supplies the several control elements.

Motor-operated stack dampers are regulated to afford a fixed combustion chamber pressure, the value of which may be regulated manually by a rheostat. The secondary air ports, which also are motor operated, are governed by regulators operating from pressure differentials between the combustion chamber and the last pass of the boiler. The coal feed to each pulverizer is governed by a motor-driven rotary feeder.

The master control functions to supply fuel and secondary air proportionately at all ratings. Changes in this relation to compensate for fuel grades, etc., can be made by manual rheostat, and any element of the control can be operated manually by push buttons. Each boiler has an individual panel carrying the instruments and controls for that boiler. A master panel carries the master control and instruments.

Coal handling is patterned after installations used successfully at gas producers and elsewhere in the Massillon works. Coal is dumped into a track hopper, passes through a crusher and over a conveyor with magnetic pulley separator, into a concrete pit adjacent to the end of the boiler house building. From this pit the coal is handled by a 5-ton crane trolley with a 2-cu.yd. bucket. The crane hoists the coal and then transports it horizontally along the bunkers, dumping it where desired.

Coke breeze is dumped through a track hopper into a second pit adjoining the coal pit, which is also served by the same crane. A third pit receives ashes from a small dump car running under the ash hoppers of the boilers. The bucket crane loads the ashes out of this pit into

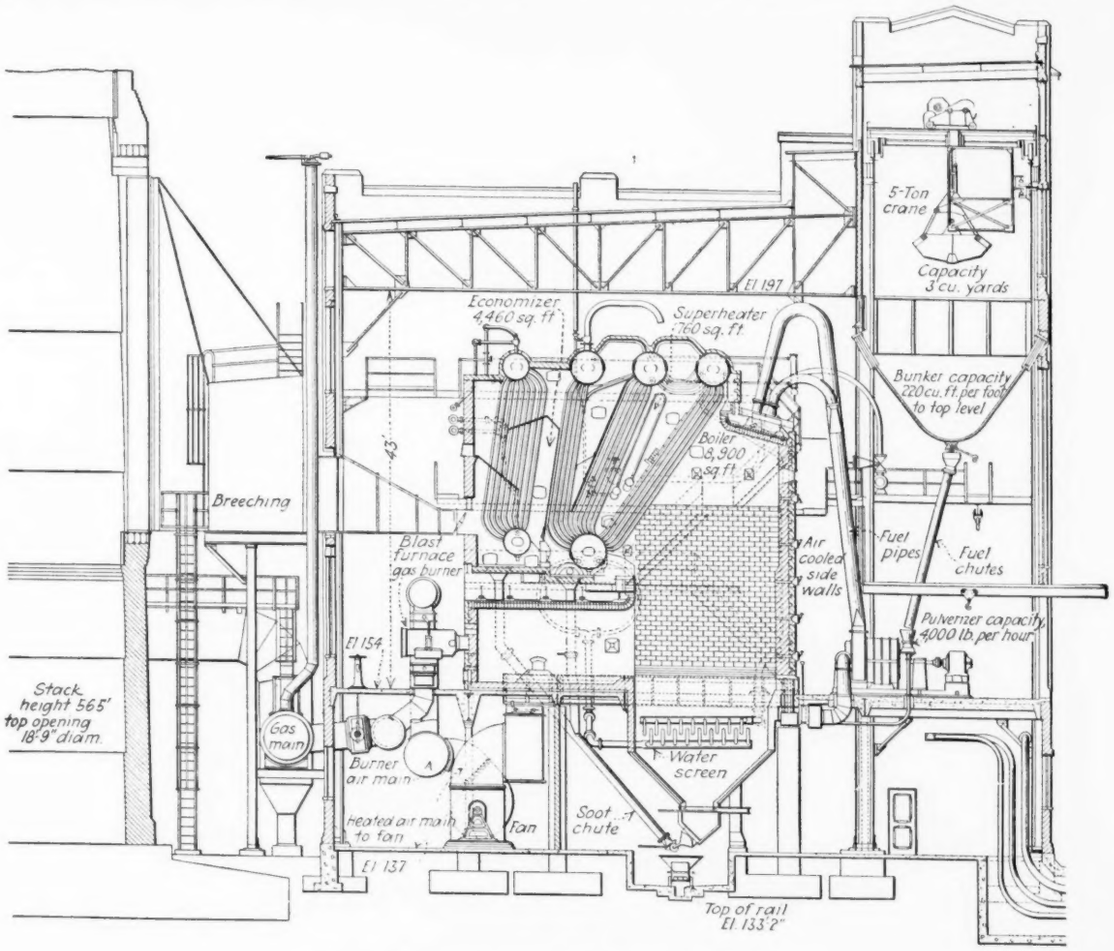

Fig. 4—Sectional elevation through boiler room

railroad cars. The relatively small amount of ashes involved would not warrant provision to run railroad cars directly under the boiler ash hoppers.

This entire coal and ash handling system has proved effective and low in operating cost and maintenance. The crane duplicates others installed in the plant, affording protection with a minimum of spares.

The entire plant is well supplied with instruments. Each boiler has a steam-flow meter, a three-point recording pyrometer, draft gages and other instruments of this nature. The principal items of steam consumption also

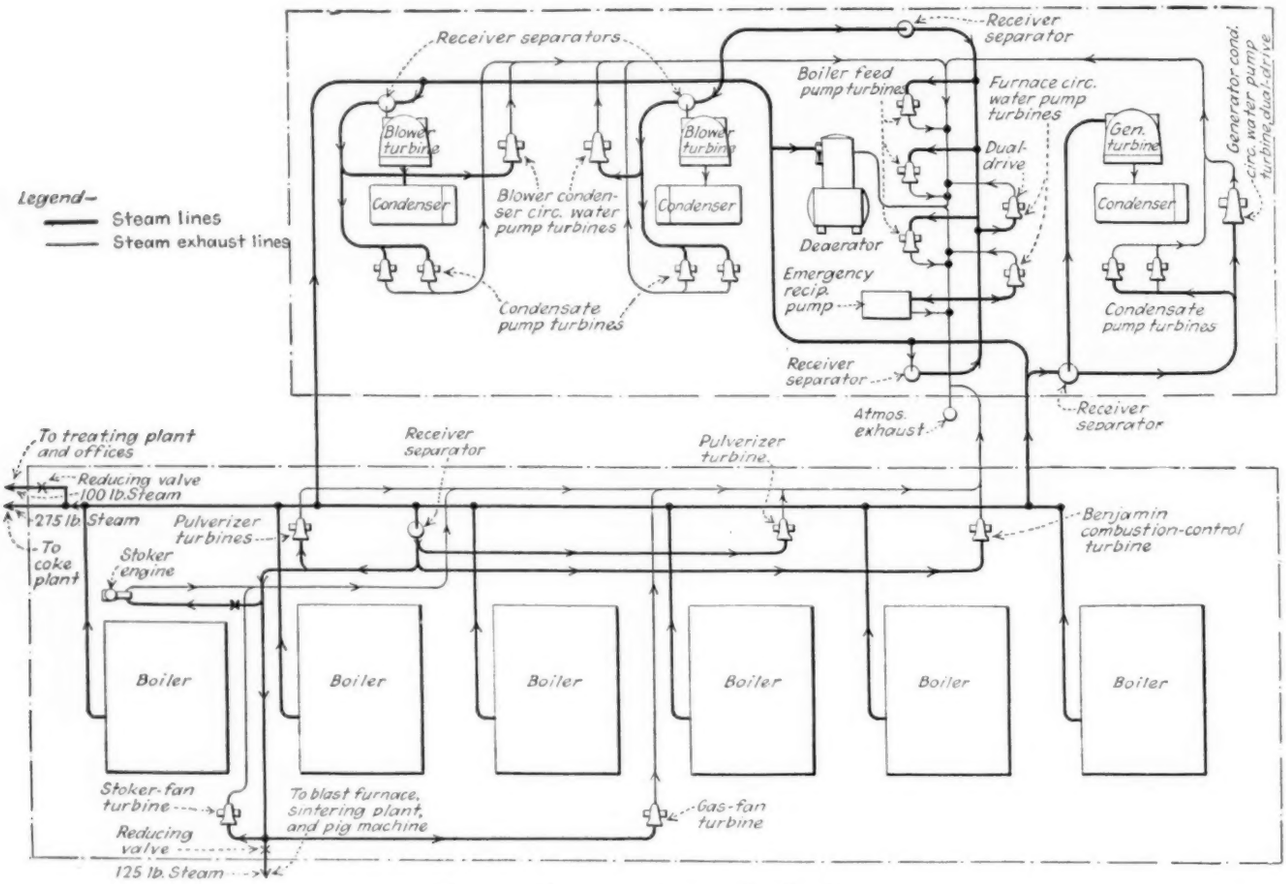

Fig. 5—Diagram of steam distribution

are metered. These, together with the recording temperature and pressure gages installed, provide means for a complete check on operations.

Hard Well Water Treated by Cold Continuous Process and Zeolite Softener

Water supply for the blast furnace, coke ovens and power plant is a matter of some interest. The location of these plants was determined primarily with a view to iron and steel production, and as a result the site is at an elevation well above the only available supply of condensing water. This water, which is obtained from wells adjacent to the Tuscarawas River, is extremely hard, averaging about 28 grains of encrusting solids. The water is not suitable for furnace cooling or for circulation in surface condensers, as scale formation occurs at relatively low temperatures. For these reasons a spray pond was constructed at the power-plant elevation. Both the condenser circulating water and the furnace cooling water are sprayed, the former by pressure from the circulating pumps, the latter by gravity from the circle pipe. The spray pond was made a little deeper than necessary to serve as a reservoir, protecting the furnace and assuring continuity of operation with minimum dependence upon the makeup supply pumps, which are electrically driven.

Raw water is supplied to the plant from four 24-in. wells at river elevation. It is pumped by three 3,500-g.p.m., motor-driven service pumps to the blast furnace and coke ovens. A portion of this water passes through a cold continuous-process treating plant, having a capacity of 60,000 gal. per hour, where a lime and alum treatment reduces the hardness to 11 or 12 grains. This water is passed through the turbo-blower jackets and generator air cooler and is then given a niter-cake acid treatment to prevent precipitation. It is then used as makeup to the spray pond.

As considerable quantities of steam are used at the blast furnace and coke ovens, particularly the latter, nearly 20 per cent boiler-feed makeup is required even though surface condensers are used for the turbo-blowers and turbine generator. For boiler-feed makeup purposes the lime and alum treated water is put through a zeolite softener to remove the remaining hardness. This water is pumped to an elevated storage tank.

Condensate from the main units, after passing through the inter- and after-coolers of the condenser air ejectors,

mixes with the required makeup from the elevated storage tank and then passes through a closed heater, steam for which is bled from the sixth stage of the generator turbine. The condensate line and the makeup line are so tied in that the elevated storage tank acts as a surge tank. This heater raises the temperature to 140 to 160

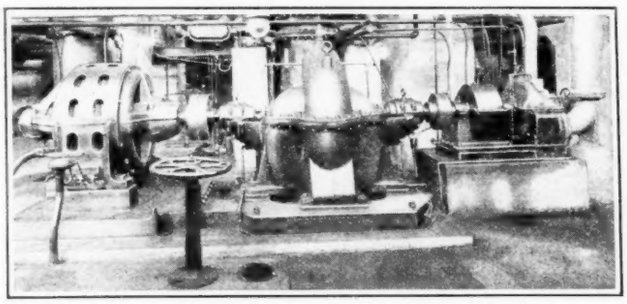

Fig. 6—Generator condenser and circulating pump with dual drive

deg. F. and delivers the water to the second stage or deaërating heater. The deaërator is supplied with exhaust steam at 4 lb. pressure from the steam-driven auxiliaries. It raises the feed-water temperature to about 207 deg. F. A vacuum corresponding to the temperature in the shell of the deaërator is maintained by a steam-jet air ejector exhausting into the after-condenser, the condensate from which is returned to the generator condenser hotwell.

Boiler-feed pumps and the blower condenser circulating pumps are turbine driven. Dual drives were provided for the generator condenser circulating pump and on one blast-furnace cooling pump, partly to afford control of heat balance, but primarily to insure continuity of operation through automatic functioning of the turbines in case the motors fail. Both the blower and generator condenser circulating pumps are arranged for speed control in order to adjust the circulation for the best over-all economy with varying weather conditions.

Blower and Generator Installations

In the power house the turbo-blowers are of interest in that they are among the first of the new General Electric design with volume control responsive to the drop across an orifice in the air intake line. The blowers have a maximum capacity of 60,000 c.f.m. and a maximum pressure rating of 32.7 lb., gage.

The single turbine generator is a 10,000-kw. 1,800-r.p.m. 11,000-volt 60-cycle machine. The voltage is a departure from usual steel-mill practice, but was selected because the bulk of the power generated is transmitted about one mile to the steel mill. Lower voltage generation would have involved excessive transmission line cost and high reactive loss. It was deemed desirable to avoid the expense of step-up transformation. The voltage selected is a multiple of the public utility supply which is received at 22,000 volts, this feature being significant with reference to step-down transformers.

The power house serves also as a substation in that a bank of step-down transformers is provided to supply the power station needs. Another similar bank supplies the blast furnaces and coke ovens. These two banks, having 2,300-volt secondaries, can be interconnected. Moreover, a spare transformer is provided, which can be cut into either bank. There also are, located in the power house, three synchronous converters which supply direct current to the blast furnace and coke ovens. As it was not desired to use 11,000-volt motors for motor-generator sets, the converters were materially lower in first cost as well as higher in efficiency.

Plant Cost Approximately $100 per Kilowatt

As this plant combines many services, any figure as to cost must be properly construed, and a unit cost per kilowatt of capacity is not directly available. Properly allocating the blast-furnace service and electric-power items, the cost of the latter, inclusive of boiler plant, spray pond, etc., and inclusive of transformation, conversion and switching for furnace and coke ovens, is but slightly in excess of $100 per kilowatt of generating capacity installed. The future addition of more generating capacity will further reduce this moderate unit cost.

Summary of Year's Operation

As performance is the measure of merit, some comment on the operation since the new plant was first placed in service, Oct. 1, 1926, may be of interest. Perfect continuity has been maintained at the boiler house. Through use of the two turbo-blowers there have been no furnace delays of import attributable to lack of wind. The single

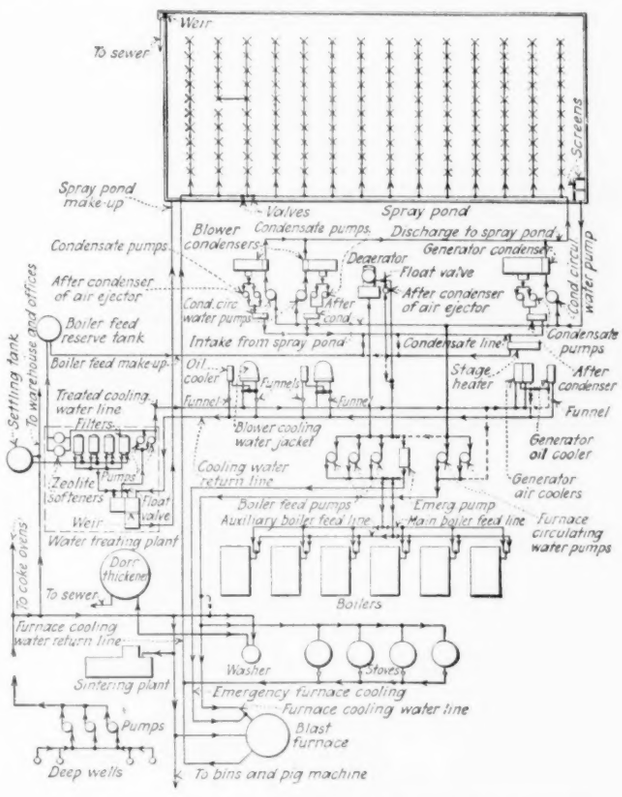

Fig. 7—Single-line diagram of water distribution

turbine generator has a remarkable record of performance in that it has operated continuously with a total outage of only nine hours, all of which was planned owing to initial inspections at the turbine and condenser.

The turbine generator has produced an average output in excess of 6,000,000 kw.-hr. per month, reaching 7,159,-

PRINCIPAL EQUIPMENT IN POWER PLANT OF CENTRAL ALLOY STEEL CORPORATION

GENERAL

Location of plant	Massillon, Ohio
Character of service	Electric power, light and compressed air for blast furnace plant
General dimensions in feet:	
Boiler house	174x76½
Turbine room	140x62
Electrical bay	140x30

BOILER HOUSE

Boilers, six, Stirling, 8,000 sq.ft.; integral economizer with 4,600 sq.ft.; steam pressure, 300 lb., superheat, 150 deg. F.; five burn blast-furnace gas or powdered coal, and one coke breeze or coal.	Babcock & Wilcox Co.
Water screens, 235 sq.ft. per boiler.	Erie City Iron Works
Gas burners, 2 per boiler	American Heat Economy Bureau
Pulverized coal burners, 4 per boiler.	Erie City Iron Works
Unit pulverizers, No. 4 Seymour impact	Erie City Iron Works
Drive	Six G. E. 75-hp. 900-r.p.m. 2,300-v. direct-connected motors and 2 Westinghouse 75-hp. 3,710-r.p.m. geared turbines
Stoker, one Harrington chain grate, 237 sq.ft.	Riley Stoker Corp. Drive, 4x4-in. Troy engine with inclosed gear
Fan for stoker, one, 27,000 c.f.m. at 4.5-in. press.	Buffalo Forge Co. Drive, one Westinghouse 30-hp. 3,660-r.p.m. geared turbine
Fans for air to gas burners, two, 60,000 c.f.m. at 7-in. press.	Buffalo Forge Co. Drive, one G.E. 100-hp. 1,800-r.p.m., 2,300-v. motor and one Westinghouse 125-hp. 3,380-r.p.m. geared trubine
Feed-water regulators, Copes	Northern Equipment Co.
Soot blowers	Diamond Power Specialty Corp.
Boiler arches	Liptak Firebrick Arch Co.
Boiler side walls, Waite & Davey blocks	Dobie & Co.
Ash hoppers and gates	Beaumont Mfg. Co.
Coal handling and crushing	Link Belt Co.
Combustion control	Benjamin Engineering Co.
Stack, 365 ft. high, 18 ft. 9 in. diam.	Rust Engineering Co.

PRIME MOVERS AND AUXILIARIES

Generator: one 10,000 kw	Curtis turbine bleeder type, 9-stage, 1,800 r.p.m., steam 275 lb. press., 150 deg. F. superheat; generator, 11,000-v., 12,500-kva., 3-ph., 60-cycle General Electric Co.
Turbo-blowers, two, 3-stage, 3,370 to 4,150 r.p.m., 50,000 c.f.m. at 18.4 to 32.7 lb. press., driven by 3,950 to 5,300-hp. 8-stage condensing turbines	General Electric Co.
Air cooler for generator, 2 units 227 sq.ft. each	General Electric Co.
Oil cooler for generating unit	Andale Engineering Co.
Oil coolers for blowers, two	Schutte & Koerting Co.
Synchronous converters, three, 6-pole, 550-kw., 1,200 r.p.m., 250-v., 2,200 amp., 6-phase, 60-cycle	General Electric Co.
Switchboards, four: One 9-panel main board, 11,000-v.; one 11-panel 2,300-v. distribution board; one 10-panel 240-v. d.c. board; one 250-v. field control board	General Electric Co.
Storage battery, emergency lighting and switch control, 110-v.	Electric Storage Battery Co.
Transformers, nine, 200 kva. 11,000-187-v., single-phase, 60-cycle; seven 500-kva., 11,000-2,300-v.	General Electric Co.

CONDENSERS AND AUXILIARIES

Condenser for turbine-generator, one, two-phase surface, 14,400 sq.ft.	Worthington Pump & Mach. Corp.
Air pump — Duplicate 2-stage, 20-cu.ft. steam-jet air ejectors	
Circulating pump, 24-in., 16,100 g.p.m., 45 ft. head; dual drive by G.E. 250-hp. 2,300-v 600-r.p.m. motor and Westinghouse 250-hp. 4,040-r.p.m. geared turbines	
Hotwell pumps, two 4-in., 2-stage, 315-g.p.m. against 85-ft. head; driven by 20-hp. 1,750-r.p.m. turbines	
Condensers for turbo-blowers, two, 2-pass, surface, 6,400 sq.ft.	Worthington Pump & Mach. Corp.
Air pump—Duplicate 2-stage, 11 cu.ft., steam-jet air ejectors	
Circulating pumps, two 16-in., 7,000 g.p.m. against 50 ft. head; driven by 125-hp. 3,370-r.p.m. geared turbines	
Hotwell pumps, four 3-in., 2-stage, 140 g.p.m., 85 ft hd.; driven by 12½-hp., 1,200-r.p.m. turbines	

PUMPS AND DRIVES

Boiler feed, three, 5-in., 4-stage Jeanesville, 650 g.p.m., 875-ft. hd.; driven by 225-hp. 1,850-r.p.m. turbines	Worthington Pump & Mach. Corp.
Plunger pump suitable 500 lb. press., 18x11x24-in., hor. duplex	Worthington Pump & Mach. Corp.
Service pumps, three 10-in., 2-stage, 3,500 g.p.m.; driven by G.E. 250-hp. 1,200-r.p.m. 2,300-v. squirrel-cage motors	Worthington Pump & Mach. Corp.
Cooling-water pumps, two, 6-in., 1,000 g.p.m., 100-ft. hd.; driven by 40-hp. 1,800-r.p.m. 220-v. motors	Worthington Pump & Mach. Corp.
Furnace circulating pumps, two, 10-10-in., 3,000 g.p.m., 100-ft. hd.; driven by 2 Westinghouse 100-hp. 1,750-r.p.m. turbines and one G.E. 100-hp. 1,800-r.p.m. 2,300-v. motor in dual drive	Worthington Pump & Mach. Corp.
Condensation pump, Jennings Hytor; driven by G.E. 3-hp. 1,750-r.p.m. motor	Nash Engineering Co.

WATER TREATING AND HEATING EQUIPMENT

Water treating plant, cold continuous process, lime and alum treatment, 60,000 g.p.h.	Permutit Co.
Zeolite softener, 2-unit	Permutit Co.
Bleeder heater, condenser type; 178,600 lb. water per hr. from 92 to 149 deg., with 10,300 lb. steam per hr. bled at 7.4 lb., abs.	Griscom-Russell Co.
Deaerating heater, Contraflo, 326,000 lb. per hr. from 140 to 195 deg. F. with 18,200 lb. per hr. aux. exhaust steam at 5 lb. gage	Griscom-Russell Co.

MISCELLANEOUS EQUIPMENT

Spray pond	Spray Engineering Co.
Cranes	Morgan Engineering Co.
Oil purifier, centrifugal	De Laval Separator Co.
Air compressor, 12x10-in., syn. motor drive	Ingersoll-Rand Co.
Piping	Pittsburgh Piping & Equipment Co.
Pipe covering	Keasbey & Mattison Co.

VALVES

Valves, steam and water	Chapman Valve Mfg. Co.; The Edward Valve & Mfg. Co.; Lunkenheimer Co.; Consolidated, Ashcroft, Hancock Co.
Motor-operated valves (Dean control)	Cutler-Hammer Mfg. Co.
Non-return valves	Golden-Anderson Valve Spec. Co.
Blowoff valves, Everlasting	Scully Steel & Iron Co.
Safety valves, Consolidated	Consolidated, Ashcroft, Hancock Co.
Atmospheric relief	Schutte & Koerting Co.

INSTRUMENTS

Steam flow meters	General Electric Co.
Pyrometers	Brown Instrument Co.
Indicating pressure gages	Foxboro Co.
Recording pressure gages	Bristol Co.
Thermometers, indicating	Taylor Instrument Co.'s.
Thermometers, recording	Bristol Co.
Draft gages	Bailey Meter Co.
Venturi meter	Builders Iron Foundry

000 kw.-hr. during the maximum month. This high output ratio, averaging on the order of 85 per cent, has been possible because of the favorable power interchange arrangement and because of the good power factor of the load. The turbine-generator unit, rated at 10,000 kw. 12,500 kva., has carried 12,000-kw. load for many successive hours without appreciable current overloads. A careful watch and record are kept of the temperature of the windings, and the water circulation in the air coolers is governed to maintain a safe condition.

Under natural draft the boilers have proved their ability to carry the ratings specified and, in efficiency, have

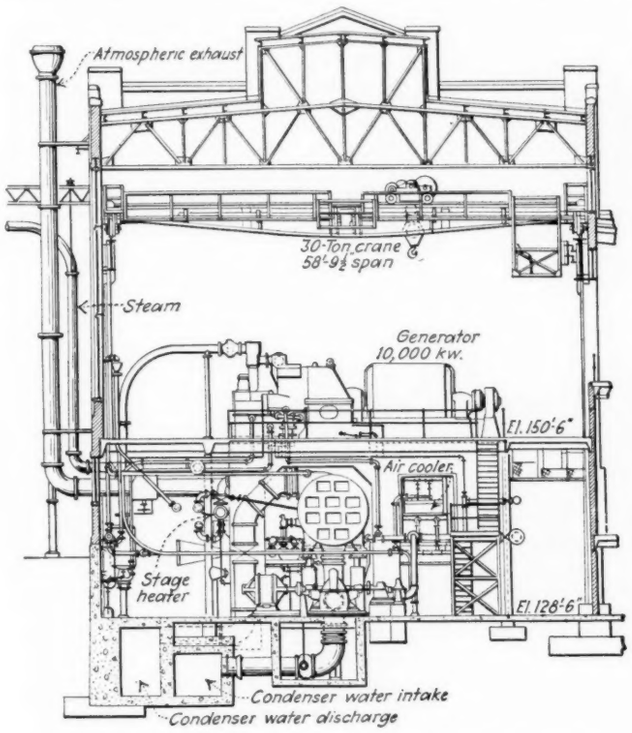

Fig. 8—Sectional elevation through turbine room

exceeded their guarantees. Equipment acceptance tests on constant loads showed over-all boiler efficiencies averaging well over 80 per cent either on blast-furnace gas or pulverized coal.

Contributing to the excellent performance of the boilers on blast-furnace gas fuel is the freedom from sludge and moisture in the gas mains and burners. This gas condition is brought about through the use of a heat interchanger in which all the entrained moisture in the gas is vaporized and a sensible heat rise averaging about 35 deg. F. is imparted to the gas. Experience has shown that this nominal rise is ample to insure a temperature above the dew point at the boilers. Because of the dry character of the gas there is no exterior encrusting of boiler tubes, and the dust deposit is much less than the ash resulting from the use of pulverized coal.

Of the total steam production approximately 65 per cent is from blast-furnace gas, 15 per cent from coke breeze and 20 per cent from Ohio slack. Approximately 25 per cent of the steam produced is used by the turboblowers and their auxiliaries. About 60 per cent of the total steam production is used for electric power generation, inclusive of auxiliaries. The remainder is process steam to blast furnace and coke ovens, together with radiation and transmission losses.

During the winter months a vacuum of about 28½ in. of mercury is obtained, and in the summer this drops off to about 27 in. An average of 13 to 13.5 lb. of steam is required by the turbine generator and its steam auxiliaries per kilowatt-hour of electric power generated. The heat input per net kilowatt-hour of station output, inclusive of losses, motor-driven auxiliaries, etc., is about 17,000 B.t.u.

The power plant operating force consists of one water tender and two firemen in the boiler house and two watch engineers, one oiler and one switchboard operator in the power house. Two men on single turn handle the solid fuel and the ashes. Two general repair men on single turn are employed largely upon work about the power plant. One chief operating engineer and one boiler-room foreman, on single turn, supervise all operations.

A system of signal interchange between the blast furnace and the power house has enabled the boiler operators to shift fuels on short notice without loss of steam pressure or wastage of heat through safety-valve losses.

Computed on a coal equivalent basis, under which both the blast-furnace gas and the coke breeze are evaluated, the operating cost per kilowatt-hour, inclusive of fuel, operating and maintenance expenses, is less than $0.003 per kw.-hr. Because of the moderate first cost of the station and the high output ratio, the fixed charges per kilowatt-hour are low, being materially less than the operating cost.

Answers To What Do You Know

The questions are on page 14

Ans. 1—Yes, it would increase the power used by the compressor by only an insignificant amount. The ammonia gas in the vertical discharge pipe exerts a pressure due to its weight upon the discharge valves, and the compressor must operate at a higher discharge pressure than before to lift the valves. As an example, if the condenser-water temperature is such that the liquefaction pressure of the ammonia is 145 lb. gage, or 159.7 lb. abs. and assuming the compressor discharge temperature to be 230 deg. F., the 70-ft. column of gas exerts a pressure on the discharge valves due to its weight of 0.189 lb. per sq.in. This is for the reason that gas at 230 deg. F. and 159.7 lb. pressure weighs 0.38 lb. per cu.ft. The total pressure on the discharge valve is the condenser pressure plus the gas weight, or 159.89 lb. abs., or 145.19 lb. gage. In this discussion the frictional resistance has been ignored.

Ans. 2—The pressure at the siphon crest is determined not by the distance to the water level of the emptying tank but by the distance to the water level in the lower, or filling, tank. The absolute pressure at the crest will be the atmospheric pressure less the pressure due to the head of water in the discharge pipe. The water level in this second tank is $15 + 5 = 20$ ft. below the siphon crest. The density of water at the assumed temperature of 60 deg. F. is 62.37 lb. per cu. ft., or a 1-ft. head of water exerts a pressure on the base of 0.433 lb. per sq.in., making the head of 20 ft. correspond to a pressure difference of 8.66 lb. per sq.in. If the pressure

of the atmosphere is 14.7 lb., the difference 14.7 — 8.66 = 6.04 lb. per sq.in., is the absolute pressure in the siphon at its crest.

Ans. 3—In order to reduce as much as possible the resistance to heat flow from the interior of the cylinder to the water jacket, the inner cylinder wall of an oil engine must be as thin as possible. If the wall becomes worn and reboring is done, the resulting thickness may not be enough to withstand the cylinder stresses. For this reason a removable liner is used in all save small engines. On the other hand, the inner wall of a steam engine can be made thick enough to stand several reborings, and so a one-piece construction is followed, as it is cheaper save in very large engines.

Ans. 4—It seems advantageous in some cases. The effect of the scouring action of the sand is to keep the tube free of scale.

Ans. 5—The infiltering air mixes with the products of combustion and lowers the gas temperature. As the heat absorbed by the tubes depends on the temperature difference between the water and the gas, less heat is abstracted by the water. The heat going out the stack is greater than in case of an air-tight setting, and the boiler efficiency is lower.

Ans. 6—Effective temperature is an experimentally determined scale which, unlike the dry-bulb and wet-bulb scales, is a true index or measure of a person's feeling of warmth in all combinations of temperature and humidity. For any given effective temperature there are various other combinations of wet- and dry-bulb temperatures at which the same degree of warmth or cold will be felt.

Ans. 7—Superheaters are placed in the combustion chambers at the rear of the boiler, although some boilers have them in the smoke connections.

Ans. 8—It is impossible to obtain perfect alignment of three or four bearings, and this is especially true when the temperatures of the two machines vary as they do in a motor-driven pump. A flexible coupling permits a slight misalignment without bearing trouble. In addition unbalancing due to runner wear is better taken care of by flexible connection.

Ans. 9—At 350 deg. F. water weighs 55.57 lb. per cu.ft., or the tank will hold 5,557 lb. of water. The heat of the liquid would be 330.2 B.t.u. per lb. At 125 lb. the heat of the liquid would be 315.5 B.t.u., a difference of 14.7 B.t.u. per lb., which is available to supply the heat of vaporization for a fraction of a pound. The 5,557 lb. would supply 81,687 B.t.u. and as at 125 lb. pressure the heat of vaporization is 874.7 B.t.u. per lb., the weight of steam given off would be 81,687 divided by 874.7 = 93 lb. This embodies a slight error as the steam is driven off at a varying pressure instead of at 125 lb.

If the tank contained steam at 150 lb. abs., there would be 100 × 0.332 = 33.2 lb. At 125 lb. the 100 cu.ft. of steam would weigh 27.91 lb. The weight of steam drawn off is then the difference, or 5.7 lb. Obviously, the tank of water gives off the greater weight of steam.

Ans. 10—The oil level should not be above the center line of the worm shaft. When the gear case is practically filled, as is sometimes done, the worm and gear act as a pump. This action decreases the efficiency of the gear, increases the oil temperature and the oil has a tendency to work out of the gear case and create a dirty condition around the machine.

Quick Thinking Meets Breakdown Emergency

By L. G. Pearce

EARLY in September the main steam-driven lineshaft of the Marietta plant of the Georgia Marble Company broke, necessitating a shutdown of the greater part of the plant. Indications were that it would take at least ten days to repair or replace the shafting, and it was essential work be resumed at once.

A conference was held, including the manager of the plant, a power company representative, a local contractor and a representative of the General Electric Company. It was decided to change the plant over from direct- to alternating-current drive. The original prime mover was a steam engine driving a lineshaft which, among other things, drove a direct-current generator furnishing power to a number of motors. A later addition to the plant, employing alternating-current equipment, had been made.

It developed that the transformers installed for the alternating-current addition were large enough to carry the entire plant when changed over to alternating-current drive. The lineshaft speed was only 155 r.p.m., driving 20 gang saws and a 150-kw. generator, all equipped with large and odd-sized pulleys.

Some 100-hp., 900-r.p.m. motors used as cotton gin drives were available, but would not meet the needs in the mill. All the motors in Atlanta known to be idle were checked. It was finally decided to relieve the direct-current generator of sufficient load to permit the use of one of the 100-hp. motors for driving it. This was done by installing a 50-hp. slip-ring motor on four rubbing beds and a 40-hp. motor on three others, thereby relieving the generator of a 65- and a 35-hp. direct-current motor. Two 100-hp. slow speed motors were then sought to pull ten gangs each. Finally, two motors, one having a speed of 600 and the other 720 r.p.m. were found and installed.

The breakdown occurred on Saturday; the conference took place on Sunday; on Monday night the generator and seven rubbing beds were put into operation; Tuesday morning half the gangs were started, and on Tuesday night the remainder were finished. On Wednesday all motors were pulling their loads safely.

Why Farming Doesn't Pay

A solicitor for a well-known farm magazine tried to sell a subscription to a farmer living in Summit County, Ohio.

"Why should I buy your magazine?" asked the farmer.

"Oh, it contains much that should interest you," said the agent. "It is full of good stories and also contains much information about how to do better farming."

"Shucks!" exclaimed the farmer, "I ain't doin' as good farming now as I know how to."—*Nation's Business.*

How many engineers are in the same fix?

Improvements in Heating System Save Four Times Their Cost

Exhaust Steam from Industrial Processes Used for Building Heating Instead of High-Pressure Steam

By J. C. Evans
Plant Engineer, Republic Rubber Company

THIS factory is engaged in the manufacture of rubber products, consisting of tires, tubes, hose, belting, packing and a complete line of mechanical rubber goods. As practically all vulcanizing of rubber is carried on by the use of steam, it is apparent that the cost of steam is a large factor in the cost of the finished product, and in order to meet competition it is imperative that steam be generated cheaply and used efficiently.

Abundant quantities of exhaust steam are available in rubber factories, but the recovery and use of them presents problems that in many cases appear insurmountable, and for this reason there are many plants where thousands of dollars could be saved by the use of exhaust steam if the problems incident to its use were attacked by competent engineers and sufficient study given to this important subject. One of the uses of exhaust steam is building heating. Before discussing this in detail, however, a brief outline of our power plant and steam using processes will make the changes made more understandable.

Power and Steam Using Equipment

Saturated steam at 150 lb. pressure is furnished by a modern boiler plant consisting of six 5,000-sq.ft. water-tube boilers, two of which are fired with 6-retort underfeed stokers and four with overfeed stokers; a 6,500-sq.ft. bent-tube boiler with 7-retort underfeed stoker.

The electric generating units total 2,650 kw., consisting of three 300-kw. generators driven by compound engines, one 750-kw. low-pressure turbine, and one 1,000-kw. mixed-pressure turbine. The engines run non-condensing with 2 lb. back pressure. Both turbines run condensing. The exhaust from the engines is fed to the low-pressure turbine and any surplus to the mixed-pressure turbine, the remainder of the requirements of this turbine being made up of high-pressure steam. The boiler feed water is heated to 212 deg. in an open heater to which exhaust steam is supplied.

About 60,000 lb. of steam per hour is used in process work in the factory, mostly in presses and heaters. The presses are trapped and the condensate is returned to the boiler feed heater.

The heaters that are employed to a great extent are cylindrical in shape, set horizontally, and measure about 6 ft. in diameter, varying in length from 12 ft. to 30 ft. They are equipped with a door at one end for the purpose of loading and unloading. The steam, ranging in pressure from 40 to 100 lb., is turned into the heater and comes in direct contact with the product. The duration of heats varies from 15 minutes to several hours, and at the end of each heat the steam must be blown out of the heaters to permit opening the doors for the removal of the product. This steam was being blown to the atmosphere, but later developments permitted its use.

Our heating system consists of a hot-water system in about 40 per cent of the plant, the rest being steam coils and radiators. This entire system was operated on high-pressure steam until two years ago.

Old Heating Systems

The heater for the hot water system is of the closed coil type and is located close to the power house, where it is near the main exhaust-steam connection to the feed water heater. Owing to this favorable layout we decided to try heating the water with exhaust steam. Calculations had shown that two pounds pressure would give the desired heat except in severe weather with the thermometer below 10 deg. above zero. It was a small job to connect the exhaust line with the water heater and to install a high-pressure connection, with a reducing valve for use in very severe weather. The results obtained were favorable. Since this change two winters have passed and so far, except occasionally during week ends, it has not been necessary to use high-pressure steam on this heater.

Seeking a Further Supply of Exhaust Steam

Although the limit of our supply of exhaust steam from engines and pumps had been reached, we were determined to go farther and try to locate a greater supply. The process heaters presented the only other available source, but as the steam comes directly in contact with rubber containing sulphur and other ingredients used in compounding, it was necessary to proceed cautiously in order to avoid getting these compounds into our pipe lines and eventually into the boilers. After many analyses the heaters which would not produce harmful results were determined, and after figuring our requirements for the remainder of the heating, it was found that a sufficient quantity of uncontaminated steam was available.

Accordingly, the blowoff of the heaters was connected to an existing exhaust steam line that had been installed

years ago, evidently with the intention of saving the steam. It was found, however, that the sudden rush of steam, when a heater was blown off, was too much for the size of our piping, causing the pressure to build up to about 20 pounds which, besides being too much back pressure on the engines, caused a great loss of time in waiting for the pressure to drop low enough to allow the heater doors to be opened for the removal of the product. As the duration of heats is very closely timed to so many minutes at a certain temperature, this delay would have caused damage to the product. Besides the existing piping being too small, it was not properly drained. This caused serious water hammer, due to the steam condensing at low points in the line. For the same reason the blowoff had to be connected to the highest point of the heaters.

Our tests had convinced us that the plan in general was feasible, and it was a simple matter to figure and install the proper size of pipe for the exhaust main. When this was done, there again was a surplus of exhaust steam, even though both turbines were generating their full load on exhaust steam. The next step was to connect the steam coils and radiators to the exhaust line, instead of to the high-pressure steam lines, and of course to add some radiation where necessary in order to compensate for the lower steam temperature. Again this was simply a matter of proper sizing of pipe and proper drainage.

Even though all the building heating is now done with exhaust steam, it is still possible to generate the same amount of electric power on exhaust, as had been previous to these changes. This enabled us to operate with one boiler less than had been possible in any previous winter. There were, however, still some kinks left to be ironed out, one of which was a slight loss of time in the operation of the heaters, due to the fact that the blowoff line had to be reduced to zero before the heater doors could be opened.

Operation of Heaters Made Automatic

Check valves were installed on the blowoff line to prevent the steam backing up into the heater, and hand valves were placed so as to vent the heater to the atmosphere. Soon after doing this, however, it was discovered that the supply of exhaust steam was diminishing, and upon checking up it was found that the heater operators were, in some cases, blowing the heater down to about 20 lb. and then were opening the vent valve and blowing the remainder to the atmosphere. This proved that the entire control would have to be handled automatically, and eventually this was accomplished. The temperatures in all processes are controlled by instruments for that purpose, and in connection with these controls there are time controllers, which at a predetermined time automatically shut off the steam. These instruments operate the steam valves by a low air pressure acting on diaphragm valves, and the problem was solved by the installation of another diaphragm valve on the blowdown line, so arranged that when the control closed the steam valve, it also opened the exhaust valve and blew down the heater. The heater, however, had to be vented to the atmosphere in order to reduce the pressure to zero. This was accomplished by another diaphragm valve on the vent line, the diaphragm of which was of such diameter that 2½ lb. held the valve shut. When the blowdown valve opens, it drops the heater pressure to 2 lb., which, being insufficient to keep the vent valve closed, allows it to open and vent the heater to the atmosphere. In order not to waste steam when raising the temperatures at the start of a heat, a hand valve was installed on the atmospheric side of the diaphragm vent valve, which the operator closes until the heater pressure has reached 2½ pounds.

The improvements were now complete, but some of the traps on the heating coils gave a little trouble, which was remedied by the use of themostatic traps. All our radiation is now equipped with these traps and the condensate returned to the feed water heater. The hot water heater has a tilting trap handling its condensate, which is also discharged to the feed heater.

During the first summer that this system operated, there was a surplus of exhaust steam even with both turbines operating at full load and using all the exhaust steam possible. This condition was remedied by installing motor drives on pumps and other auxiliaries in place of steam drives.

During week ends, in very severe weather, we occasionally have to use a little high-pressure steam, but usually the buildings can be kept at about 50 deg. by running steam-driven pumps and an engine. In summer, during week ends, we use a motor generator and motor-driven pumps operating on purchased power.

The total cost of these changes has already been repaid four times by savings of coal, and we are obtaining better results from our heating system than was ever possible before the use of exhaust steam, and in addition we have a flexible system which gives an ideal heat balance.

All the work incident to these changes was done by our own men. The material was specified by the plant engineer and purchased through our purchasing department. In this way the selection of materials is based on the judgment of the engineer and with the co-operation of the purchasing department, favorable sources of supply, prices and delivery are assured.

What Is a Boiler?

By Arthur L. H. Street

THE boiler of a hotel heating plant was insured against "explosion, collapse or rupture," under a standard insurance policy. Gas was used as fuel and some accumulated in the firebox, where it exploded when the operator undertook to light the jet, causing slight injury to the boiler and considerable damage to the firebox and the chimney.

The district court in Dallas rendered judgment against the insurance company for $1,500, but the Texas Court of Civil Appeals set it aside, for reasons stated as follows (Hartford Steam Boiler Inspection & Insurance Company vs. Kleinman, 293 South Western Reporter, 894):

"The firebox and chimney were parts of the heating plant but not parts of the boiler described in the policy. Especially is this true in view of subdivision (c) of paragraph 3, wherein was stated what the word 'boiler' was understood to include. The explosions having occurred in the firebox and chimney from gas there accumulated, the resulting damage is not protected by the policy."

ELECTRICAL
Operation and Maintenance

Sequence Relay on Elevator Prevents Fuses Blowing*

By O. F. Dubruiel

ON SOME of the older types of elevator controllers the armature resistance is cut out of circuit by mechanical means. When the controller is centered to stop the machine, the arm on the starting rheostat is moved to the position that connects all the resistance in series with the armature. When the operating cable is pulled to the on position, the rheostat arm is allowed to fall by gravity to a position where all the resistance is cut out of circuit as the motor comes up to speed.

One of the disadvantages of this system of control is that if the power fails and the controller is not centered, the armature resistance will be cut out of circuit when the line is again made alive, which will result in an inrush of current through the motor that will blow the fuses. If interlock switches are used on the landing doors, and the operator, when starting the car, pulls the control to the on position before closing the doors,

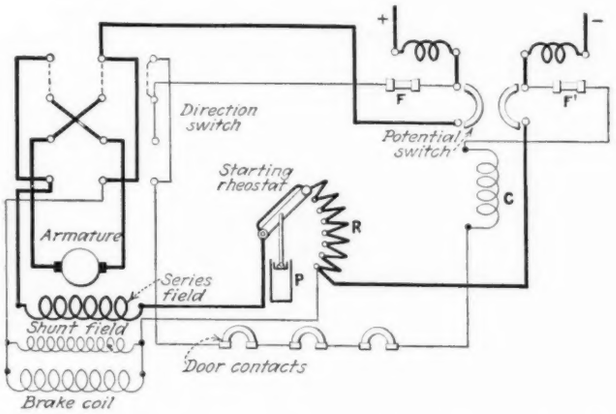

Fig. 1—Original connections of the elevator controller

the fuses would likely blow. The latter was the trouble with an elevator of which I had charge.

The diagram, Fig. 1, shows the original connections of the controller. When the controller is pulled to the on position, the reverse switch is closed to either the up or the down position and the arm on the starting rheostat is released. Assume the direction switch closed to the up position, as indicated by the dotted lines. This would complete a circuit for the potential-switch coil from the + side of the line through fuse *F*, the right-hand side of the direction switch, the door contacts and coils *C* on the potential switch. Energizing coil *C* causes the potential switch to close and complete the motor's

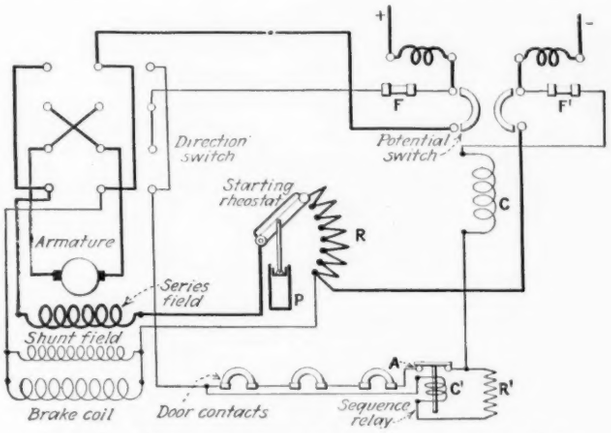

Fig. 2—Elevator controller with sequence relay

circuits. As the motor comes up to speed, the starting rheostat arm slowly falls and cuts out the starting resistance. The rate at which the arm falls is controlled by the dashpot *P*.

From the foregoing it was seen that the door contacts are in series with the potential-switch coil. As long as these contacts are open, the potential switch cannot close, even if the control is in the on position.

Trouble was experienced with the fuses blowing because the operator pulled the controller to the on position before closing the hoistway doors. In some cases the closing of the doors was delayed long enough to allow the starting rheostat arm to fall and cut all the starting resistance out. Then, when the doors were shut and the potential switch closed, the motor would be connected directly to the line and the fuses blown.

To overcome this difficulty, I made a sequence and relay and connected it into the potential-switch coil circuit as shown in Fig. 2. If a door contact is open and

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the direction switch is closed by pulling the control to the on position, a circuit is made from the + side of the line through fuse F, coil C' and resistance R' of the sequence relay, and then through the potential-switch coil C to the — side of the line. The current flowing in this circuit is sufficient to cause the sequence relay to open its contacts A, but not close the potential switch.

When the landing door is closed, the circuit for the potential-switch coil C is open at A and this switch cannot close, consequently the motor circuit is not energized. Before the motor circuit can be made alive, the controller must be centered, which will open the sequence-relay coil circuit in the direction switch and let the contact of this relay close, as shown in Fig. 2. Then, when the control is again pulled to the on position, a circuit is made through the door contacts, contacts A on the sequence relay and coil C without going through the sequence-relay coil C' and resistance R'. This connects coil C directly across the line, and it closes the switch.

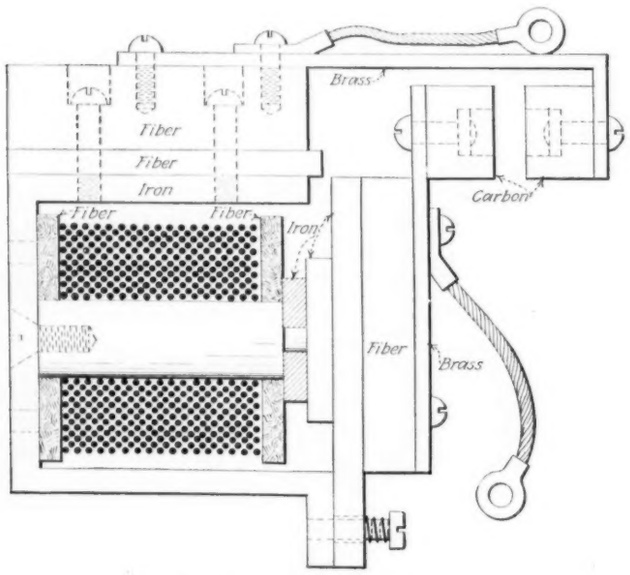

Fig. 3—Assembly of sequence relay

The sequence relay cannot function now, because its coil and resistance are shunted by the door contacts and the relay contacts A. From the foregoing explanation it is evident that the controller cannot function except when the landing doors are closed, before the controller is pulled to the on position.

A simple type of relay designed for the voltage of the elevator circuit may be obtained from one of the control manufacturers. For my purpose, as previously mentioned, I built the relay using a coil of 6,200 turns of No. 33 enamel-insulated wire, wound on a $\frac{7}{16}$-in. round-iron core $1\frac{3}{8}$ in. long with a $\frac{1}{8}$-in. fiber disk on each end, $1\frac{3}{8}$ in. in diameter. This gave a winding space $1\frac{1}{8}$ in. long by about $\frac{7}{16}$ in. deep. Five ounces of wire was used and 800 ohms resistance was connected in series with the coil. The relay was of the type shown in Fig. 3, which is about the full size of the device.

Bending Copper Tubing

COMPLYING with the request of R. C. Martin in the Oct. 18 issue, regarding the best way of bending copper tubing for electrical work, the following practical notes may be of interest: There are many methods and devices adopted in power plants and general engineering industries for bending copper pipes and tubes, much depending on the size of the tubing and the amount of bending to be done. Up to about 3-in. diameter, manual labor is sufficient; above that power-driven tube bending machines are generally employed.

For determining bending allowances and the permissible bending radius for a tube of given diameter, the rules given here will be found useful. In determining the required length of a tube before bending, the length of the straight sections are, of course, added to that of the curved sections in order to make the correct allowance for bends.

To find the length of a 90-deg. or right-angle bend, multiply the radius of the bend by 1.57. The radius is measured to the center of the tube or to a point midway between the inner and outer walls. To find the length of a 180-deg. or U-bend, multiply the radius of the bend by 3.14. Example:

A right angle or 90-deg. bend is to have a radius of 10 in. and straight sections on each side of the bend are to be 5 and 15 in. respectively. Find the total length of the pipe before bending. Length of curved part equals $1.57 \times 10 = 15.7$ in.; hence total length equals $15.7 + 5 + 15 = 35.7$ inches.

A general rule for finding the lengths of sections having degrees of curvature other than 90 and 180 is as follows: Multiply the radius of the bend by the included angle and then multiply the product by the constant 0.01745. The result is the length of the curved section.

A simple method of preventing buckling or flattening when bending the tube by hand and on a small scale, consists in using some filling material which is placed inside the tube to support the walls to prevent buckling, puckering or flattening in the throat of the bend. Lead, rosin, pitch, and rosin and pitch in equal parts are the substances mostly employed.

A snugly fitting coil spring may be used instead of one of the filling materials mentioned. One method of removing the spring after bending is to fasten one end of the spring in a lathe spindle, which is then rotated so as to wind the spring in whatever direction will reduce its diameter. The spring should be lubricated before using.

Copper tubes up to and including $\frac{3}{4}$-in. bore can be readily bent without annealing or loading, but in the case of larger sizes it is advisable to proceed as follows:

1. Heat the tube to a dull red heat at the portion to be bent and cool by quenching in water. It may be mentioned that the process of annealing copper tubes differs in practice at different plants. The customary method in our coppersmith's shop is to heat them uniformly to 650 or 700 deg. F. and then to plunge them into water. Copper tubes are frequently sold in the hard

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or semi-hard state in order to prevent them becoming distorted when handling.

2. When cold, fill with rosin, pitch or dry sand. If the latter material is used, stamp it down well and plug both ends of the tubing with wood plugs. When rosin is used to fill the tube one end of it should be temporarily plugged up and molten rosin poured in, or lump rosin can be fed into the open end while the tube is made hot enough to melt it. In any case, it should be borne in mind that rosin is inflammable when in the molten state.

3. Bend cold to shape desired. The bending operation may be done round a wooden block of the desired shape, or a simple and inexpensive bending machine may be used.

E. ANDREWS.

Manchester, England.

AFTER reading the request of R. C. Martin, in *Power*, Oct. 18, for information as to how to bend copper tubing, it is to be assumed that Mr. Martin does not mean copper pipe, also that he is aware that the metal in copper tubing is not of sufficient thickness to permit threading for standard pipe fittings, while copper pipe may be threaded for these fittings.

It is with interest that I note the comments and recommendations in the Nov. 15 issue. The methods suggested for doing the bending will work. However, it is not common practice among pipe benders to do the job that way. Neither is it practical from a commercial point of view. No contractor working on a flat contract basis and few working on a cost-plus basis would supply the material or permit the time necessary to prepare the

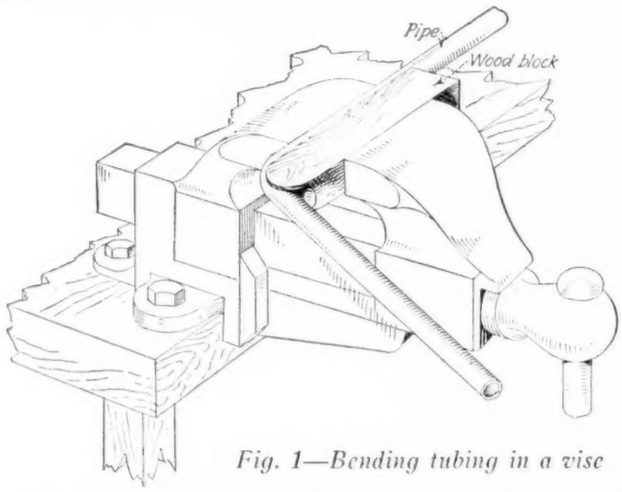


Fig. 1—Bending tubing in a vise

tubing in the manner suggested for bending. Figs. 1 and 2 show two inexpensive methods in common use by practical men doing pipe bending work. There are also other inexpensive methods of doing the work, and tubing bent by any of the methods will not be buckled or kinked. Then there are the more elaborate methods consisting of the various patented devices.

The first method, Fig. 1, is to use a piece of hard wood with one end rounded, using a radius equal to half the width, then groove this rounded end to a depth equal to half the outside diameter of the tubing. Clamp the block and the tubing in an ordinary bench vise as shown, and then pull the tubing around the block to make the desired bend.

In the second method, Fig. 2, two iron grooved wheels of any desired radius are used; the grooves on the outside diameter of the wheels should be made on a radius to fit the tubing to be bent. Mount these two wheels between two pieces of flat iron or wood fashioned at one

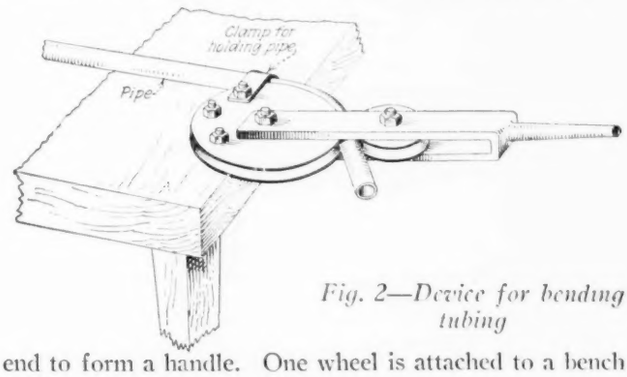


Fig. 2—Device for bending tubing

end to form a handle. One wheel is attached to a bench as shown or held in a vise.

Either of the two figures shows implements that do not cost much to make and are used extensively by practical men working tubing or pipe. Tubing or pipe bent this way does not require filling with sand, rosin or any other material, neither is it necessary to apply heat.

Pittsburgh, Pa. B. M. ADAMS.

Danger from Low-Voltage Shocks

THE editorial in a recent issue of *Power* on the danger of shocks from low-voltage circuits interested me greatly. It is possible for a shock from a circuit at only 40 volts direct current to prove fatal. At a generating station in the North of England a considerable amount of coal was being pilfiered from a storage pile. The management decided to electrify a barbed wire fence that surrounded the coal dump and chose 40 volts as being sufficient to give an unpleasant shock. One morning the body of a boy was found dead on the fence. The cause of his death was electrocution. It had been raining all the previous day and all that night, so that the boy was standing on wet ground when he touched the wire. On account of a weak heart the shock proved fatal.

Another fatal accident was caused in a stokehold, owing to the ends of some electric wires being left bare on the ceiling. There had once been a lamp where the wires were exposed, and the electrician who removed it had neglected to insulate the bare wires or had done this improperly and the circuit had been forgotten. A stoker was walking along the passageway carrying a fire rake over his shoulder. This rake caught the bare wires, and as he had a firm grip on the other end, he received a shock that proved fatal. He might have recovered, but those who were conducting artificial respiration on him left off as a doctor pronounced him dead. In the case of electric shock artificial respiration should be continued for at least two hours even if the person appears dead.

Brentford, England. W. L. WARNER.

EDITORIALS

POWER was founded in November, 1884, by Emerson P. Harris and H. M. Swetland. With it was incorporated a paper called "Steam," which had been started by N. Hawkins in Chicago two years earlier.

A few years later ownership passed to H. M. Swetland and James H. McGraw; then to John A. Hill; and with the consolidation of the Hill Publishing Company and the McGraw Publishing Company in 1917, it became the property of the McGraw-Hill Publishing Company.

Robert Grimshaw was the first editor of "Power." Subsequent editors for short periods were George L. Fowler, A. D. Risteen and Franklin VanWinkle. F. R. Low became editor in 1888, which position he still holds.

The present editorial staff of "Power" is F. R. Low, editor; C. H. Berry and A. D. Blake, associate editors; and Thomas Wilson, F. A. Annett, F. L. Beers, L. H. Morrison, A. L. Cole, R. B. Purdy, G. L. Montgomery and E. R. Goodridge.

Practices Leading to Small Profits

PRODUCTION problems in industry are now pretty well in hand, and a final effort is being made in many plants to take up any further slack through effecting savings in the cost of power.

Increased distribution costs, however, are causing concern to many industrial executives. In new lines and new fields this is to a large extent inevitable, but with standard equipment that goes to industry, it reflects conditions susceptible of study and remedy.

On the whole, output was large in 1927, two per cent over 1926, although somewhat spotty. Over-capacity in certain industries led to keen competition and price cutting. Advantage was soon taken by the purchaser of these conditions and a "buyer's market" prevailed, accompanied by small profits compared with volume of business.

The habit of calling for a multiplicity of bids when, in the purchaser's mind, selection is narrowed to two or three makes; secrecy as to prices quoted; asking for revised bids; and the inclusion of special designs when standard equipment would suffice—all these tend to increase selling costs, which must be paid for out of decreased earnings or by the purchasers in general.

It is to the purchaser's advantage that the manufacturer make a fair profit in order to be able to do the research and development work necessary to a growing field.

By eliminating unnecessary bidders, instituting frankness on the part of the purchaser as to prices quoted, permitting a study of bids lost, and building up a more co-operative spirit among the manufacturers, some progress can be made.

Chicago Smoke Prevention Receives a Setback

INDICATIONS are that Chicago is to lose its Smoke Inspection Bureau. Some three months ago the bureau was transferred from the Department of Health to that of Boiler Inspection, and the next step was the recent recommendation by the chief boiler inspector that the thirty engineers in the Smoke Inspection Bureau be replaced by boiler inspectors. Apparently, this recommendation has been concurred in by the finance committee of the City Council, for no appropriation has been made for the Bureau in 1928, and if adopted by the City Council, it will mean that thirty civil service engineers trained for years in smoke prevention will be replaced by men of unknown qualifications for this specific work. While some of the city boiler inspectors are reported to be competent engineers familiar with combustion problems, others admittedly would not be as competent, particularly as it is proposed to minimize smoke by a program of education and co-operation. Even at best, with men having the proper foundation to work on, it would take months of training to evolve a force efficient in smoke prevention, and in the meantime, with suspension of activities, the chances are that Chicago, so far as smoke is concerned, would revert to conditions prevalent some twenty years ago.

At that time the department was operated purely on a political basis, and conditions became so intolerable that

the civic bodies of the city and the citizens arose *en masse* to demand relief. As a result the department was reorganized on an engineering basis. A competent engineer was made chief smoke inspector, the personnel of the department was made up of civil service men with proper qualifications and, of outstanding importance, the department was divorced from politics.

Within three years the new smoke bureau and its operations became a standard for other cities. The smoke evil was checked and conditions greatly improved. The Bureau has continued to function efficiently throughout the years, and at the present time Chicago is one of the cleanest cities burning bituminous coal.

Now at the whim of the present administration, or what not, it would seem that the Smoke Inspection Bureau, as such, is to be obliterated by the simple process of providing no appropriation. The thirty engineers and their years of training and experience are to be eliminated over night. Smoke prevention is to be carried on as a side issue. Along with their numerous other duties it is proposed that the boiler inspectors enforce the smoke ordinance.

Chicago knows the cost of grime and soot. With the city's good at heart the same interests that acted so effectively twenty years ago must act again, and promptly, if the present Smoke Bureau, which has done so much good for the city and the country at large, is to be retained.

Rating Oil Engines

RECENTLY, a governmental agency, in comparing bids on oil engines, proceeded to reduce the quotations to dollars per brake horsepower. In doing this an arbitrary set of mean effective pressures were used, and regardless of the builder's rating, each engine was credited with a brake mean effective pressure according to the cycle employed by the engine. The intention was good, but the results cannot be commended without reservation.

At this late stage in oil engine history those familiar at all with the art know that broad classifications do not determine an engine's reliability or yet its power. Because two engines employ solid injections to introduce the fuel charge, and operate on the four-stroke-cycle, does not necessarily prove that they will develop the same indicated horsepower.

Too many structural factors are involved to make the problem so easy of solution. If the method were to be generally adopted, certainly some of the classifications would be filled with strange bedfellows. It would seem that this standardization of effective pressures has been evolved as a makeshift answer to the acknowledged need of some method by which oil engine bids could be compared intelligently. That the plan involves injustices apparently is of little moment to the plan's sponsors, as compared to the fact that a standard has been developed.

Why should an arbitrary mean effective pressure be allocated to a given engine type? Would it not be far preferable to credit the engine with the pressure it can develop safely and continuously? Why not erect a rule based upon what an engine can actually do?

It is never advisable to load an engine to its maximum capacity, although some builders approach this limit closer than do others. Would it not be logical to require that the marketer of an engine rate the machine at a set percentage of the maximum pressure the engine can develop without more than a definite drop in speed?

Where the purchaser understood the limitations of a design, he could disregard the standard rating if he so desired.

Still another sound rating method embraces the engine's efficiency. In steam-engine work it is usual to rate the engine at about the most efficient cutoff. Why should not the Diesel be rated in somewhat similar fashion? It would not be necessary to base the rating at the lowest point in the fuel-consumption curve, but the chosen point should not be too far away. This plan permits each engine to take advantage of any and all favorable design points.

Surely, a safer method than that based on cyclic characteristics is needed. The objection frequently voiced is that the power obtained from an oil engine cylinder is small compared to the cylinder dimensions and engine weight. If designers can remove this by increasing the power developed, why set up interfering rules?

Imagine the Savings!

IMAGINE what a difference it would make in the steam wasted at some plants if the steam lines out in the manufacturing departments were as free from leaks and as well insulated as is the steam piping in the power plant. Steam leaks, besides the direct loss of steam, make a sloppy, unsightly plant, and often rust out good equipment as a result. Uncovered mains or branches not only put heat where it is not wanted, in an unregulated way, but also often lower the efficiency of equipment by supplying it with steam of lower temperature and higher moisture content than is desired.

But, inspecting the steam piping out in the plant would take up some of the power engineer's time and would necessitate his going outside the four walls of his plant. And he might find conditions that would make him want to spend some money on material and labor for repairs and changes, which might get him into an argument with the management.

And the management, being mainly interested in the unit cost of the product being turned out, is not interested in savings made in steam cost. Oh, no! But somebody ought to do this job. And if they did, imagine the savings that could be made!

IDEAS *from* PRACTICAL MEN

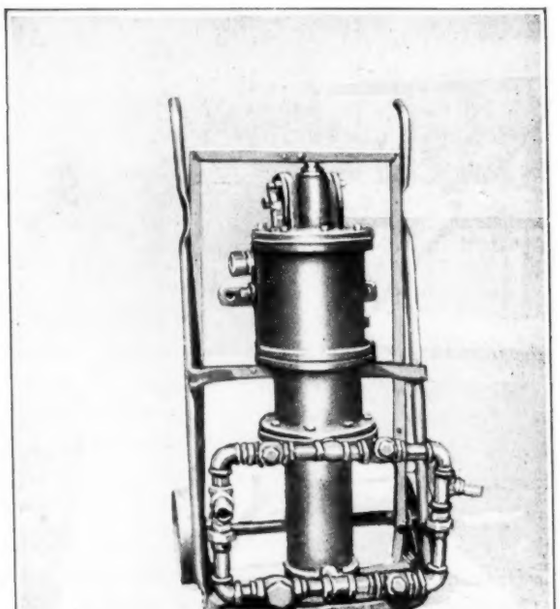
Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Home-made Hydrostatic-Pressure Boiler-Test Pump

THE accompanying illustration shows how a handy and practical boiler-test pump was made from the air compressor of an old locomotive.

The original air cylinder was discarded and a special brass water cylinder cast at a local foundry. One end of the brass cylinder was closed and the other open, the open end having a flange for attaching it to the steam cylinder. Water connections 1½ in. diameter were provided at each end of the cylinder. The original air piston was used for the water plunger.

A rectangular assembly of 1½-in. fittings, including four check valves, formed the inlet and discharge water connections. The general arrangement will be readily understood from a study of the illustration, all four check valves being set to direct the flow of water in the same direction.



Boiler-test pump built from locomotive-type air compressor

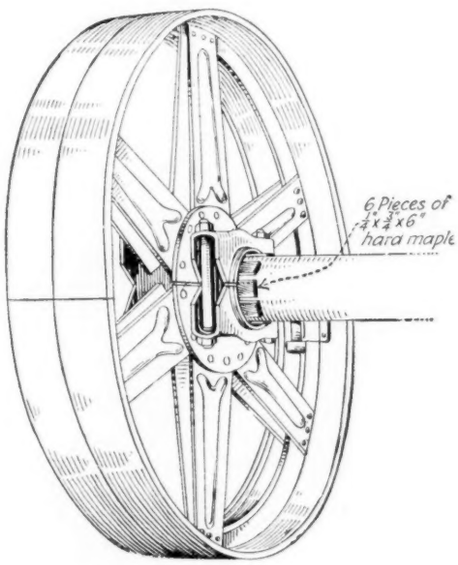
It is best to use spring-loaded check valves, as the springs help close the valves and prevent small back gushes of water. If spring-operated valves are not used, it will be necessary to install the valves in an upright position. The larger the fittings and valves used the more speed the pump will have, although the 1½-in. connections used are entirely satisfactory. The pump is placed on a floor truck as shown, and is readily moved around the plant. When used for testing boilers, it is connected with one of the plant boilers and operated by steam from it.

L. M. JORDAN.

Cairo, Ga.

Emergency Bushing for Split Pulley

AN EMERGENCY called for a 24-in. pulley to run a machine temporarily at a different speed than the one used. A pressed-steel pulley of the proper diameter was on hand, but the bushing was too small for the shaft. As the job was required in a great hurry, it was not expedient to order a bushing of the proper size or have one made in the shop.



Hardwood pieces used as emergency bushing

The hole in the hub of the pulley was 4 in. and the shaft on the machine which the pulley was to fit was 3½ in. Eight strips of hard maple were quickly cut in the wood shop ¼x¾x6 in. long. These were equally distributed around the shaft in the pulley hub and the bolts were tightened up. The pulley ran true and carried a load for several hours. In fact, the arrangement was so satisfactory that I could see no reason why it would not have run indefinitely. In any case, it saved a great deal of time, which was important in this case.

Syracuse, N. Y. H. L. WHEELER.

Waterglass as a Base for Paint

THE practical letter in the Nov. 1 issue on "Painting Insulated Pipe Lines" caused me to recall some of my early experiences. Years ago while working as apprentice boy, I occasionally painted steam mains, my old-fashioned boss having the idea that if a boy desired to learn the machinist's trade he should do a little of everything in the shop.

I had to cook a kind of glue with which to give the pipes a first coat. Performing this task in the blacksmith shop, I was obliged to listen to outbursts of profanity and watch the threatening gestures of two sinewy and hot-tempered blacksmiths every time they thought that they could smell the bad odor of burnt glue.

Recalling how I had repaired an old keepsake made of porcelain with waterglass, I suggested to the boss that this could be used when painting insulated pipes, instead of glue. After a talk with the warehouse man, the old sea-dog and engine builder conceded.

Waterglass adds to the strength of the surface and is more easily applied.

A. LEKSTROM.

Ironton, Minn.

How Correct is the Average Steam Flow Meter?

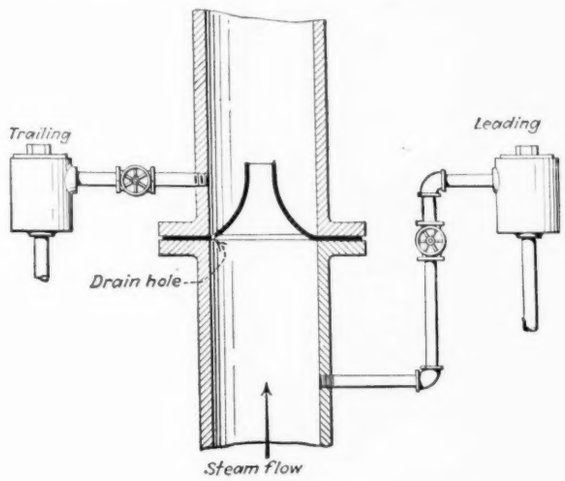
AN ELECTRICALLY operated flow meter was connected to an 8-in. steam main, the flow nozzle being installed in the vertical leg of the line, as shown in the accompanying sketch. During the summer months the flow of steam through the nozzle was so as to give a 24 per cent chart reading or 0.4 in. reading on a mercury manometer.

The ½-in. lines for the differential pressure were tapped 10 in. and 4¼ in. at the inlet and outlet, respectively, of the flow nozzle.

After a short interval of operation at this low chart reading the meter went down and indicated zero, although it was known that the quantity of steam being used was somewhat about the same as when the meter indicated 24 per cent chart reading. The two ½-in. lines were blown out, and after they were both filled with condensate the meter was put back in operation and read about 24 per cent on the chart as before, but gradually returned to zero after about 45 minutes had elapsed. A mercury manometer was then connected to the ½-in. lines, after they had been again blown out, and when the lines were again filled with condensate the manometer read 0.4 in. mercury deflection, but this continued to become less until it again read zero. It was then decided that owing to the low velocity of the steam through the flow nozzle there was some water head gradually building up on the trailing, or low-pressure, side of the nozzle, and this head was about right to overbalance the drop in pressure of 0.4 in. mercury that was occurring through the nozzle.

In flow nozzles of this type there is a small hole for drainage drilled in the flat of the nozzle near the beginning of the curve, and on removing this flow nozzle from the line, it was found that solid matter, presumably carried over from the boilers owing to priming at some time, had gradually filled up about one in. deep around the flow nozzle and had eventually plugged this drain hole. This caused the pocket around the flow nozzle to fill with condensate and create a head pressure on the low side of the meter to offset the small differential caused by the steam flow through the nozzle, and allow the meter to return to zero. After this deposit had been cleared and the flow nozzle replaced in the line and steam turned on the main, the two ½-in. lines were blown out and allowed to fill up with condensate, the meter was put in operation and returned to its normal 24 per cent chart reading for summer load. When this steam main was again closed for repairs at a later date, the flow nozzle was removed and properly installed in a horizontal line where there would be no possibility of a different water head being formed.

It would seem in vertical steam lines with an up flow, where a flow meter is to be installed, there would be less danger of incorrect readings if a flat orifice plate were used in preference to the flow nozzle. This would remove the danger of a water head being formed, which would in turn cause the meter to read low by the difference in water levels measured from the bottom of the ½-in. horizontal pipe to the trailing condenser up to the



Arrangement of flow nozzle in vertical pipe and connections to meter

extreme top of the outlet side of the flow nozzle. This low reading will be practically maintained throughout the full range of chart readings and, as stated here, would have had nearly the same effect on the meter readings as though the two condensers, instead of being installed level with each other, had been installed so that the trailing condenser was 7 in. higher than the leading condenser. If a flow nozzle has to be used, it should be seen to at regular or periodic intervals that the drain hole is kept free, so there will be no condensation remaining in the pocket formed by the nozzle that will rise above the meter connections, especially when the water is spilled from the trailing condenser, owing to an increased velocity through the flow nozzle and an increase in steam flow.

The steam main could also be tapped opposite the trailing pipe line and just below it, and a small trap installed to overcome the danger of condensation at this point. For if a plant is selling steam to some consumer, the loss due to one-tenth of an inch mercury deflection that is incorrect, will soon equal the expense of keeping the flow meter correct.

WILLIAM H. BURTON.

South Somerset, Mass.

COMMENTS *from* READERS

Can a Throttling Governor Be Applied to a Corliss Engine?

I SHOULD like to inquire of the readers of *Power* if it would be possible to connect a throttling type of governor to a single-eccentric 10x30-in. Corliss engine. This engine has an extremely variable load, from practically nothing up to about one-half normal rating. The steam pressure is 100 lb. gage.

It seems impossible to adjust the present governor and valves to hold a steady speed, and I should like to know if it would be practical to connect a throttling governor to act as a pressure regulator and cause the engine to hold a steadier speed through the quick changes in load.

Nampa, Idaho. O. M. HAMILTON.

* * * *

Starting Diesel Engines With the Generator

THE articles that have appeared recently in *Power* on starting Diesel engines in the absence of starting air, have been read with much interest.

The trend of the discussion has been to start the engine by running the alternator as a synchronous motor. The objection to this procedure is, of course, that of shutting the plant down while doing so.

In some types of oil-engine units the alternators are equipped with an amortisseur, or squirrel-cage winding, attached to the pole faces, which not only serves to dampen out any oscillation due to the pulsating torque of the engines, but also provides a squirrel-cage starter winding which is supposed to start the alternator readily as an induction motor.

I should be glad to hear from someone who has tried out starting a Diesel by running the alternator as an induction motor, also as to just what procedure was employed. E. E. GAMET.

Trenton, Mo.

* * * *

What Caused the Pitting on the Turbine Bearings?

IN THE Sept. 27 issue J. W. Baker asked for suggestions as to "What Caused the Pittings on the Journals of a New Turbine Generator Unit?" I should like to submit the following answer:

The pitting was undoubtedly caused by the access of moisture or water to the affected bearings in some manner. If the bearings were not of a tightly inclosed type, condensation of atmospheric moisture on the journal would account for the water. It is likely that this machine was in storage or in transit for considerable time and during this period moisture entered the bearing and collected on the affected journals.

The destructive corrosive effect of even a small amount of water or moisture on polished steel surfaces is in marked contrast to the effect of unpolished or rough surfaces. The attack in the former case is more rapid and is generally concentrated in spots, thereby causing pitting.

In order to prevent this corrosion, polished surfaces, such as the journals of any machine which is to be in storage or transit for a considerable period, should be carefully coated or slushed with a good grade of rust preventive compound, preferably the heavy grade which sticks well and stands high climatic temperatures without running off the surfaces. The presence of lubricating oil in the bearing wells or the lubricating system is not a positive insurance against corrosion when a machine is idle for a long period. An idle machine should be jacked over and the oil circulated at least once a week. If a machine is to be laid up for an indefinite but long period, the journals and other parts susceptible to corrosion should be coated with a good rust preventive compound. Furthermore, these parts should be inspected once every six months, and preferably every three months. T. A. SOLBERG,

Annapolis, Md. Lieutenant-Commander, U.S.N.

* * * *

How They Got an Extra Half Kilowatt per Gallon of Oil

THE attached memorandum illustrates a simple method of indicating saving in dollars and cents by improvement in the fuel economy of an oil burning steam plant in one year over another, that may be of interest to *Power* readers.

In the year 1924, 3.41 kw.-hr. was generated per gallon of oil. In 1925 the production was increased to 3.93 kw.-hr. per gal. If production in 1925 had been on the same fuel economy basis as 1924, results would have been as follows:

$$\text{Oil used, } \frac{13,582,040}{3.41} = 3,983,000 \text{ gal.}$$

Actual oil used,	3,453,429 gal.
Saving over 1924	529,571 gal. or approximately 12,600 bbl.

At $1.75 per bbl. this means a saving of $22,050.

This result has been achieved with no major plant changes and is believed to be due to: (1) More scientific system operation; (2) continuous daily check on economy; (3) better maintenance; (4) more thorough instruction of operating employees.

F. KRUG, Supt. of Power Production,
Porto Rico Railway Light & Power Co.
San Juan, Porto Rico.

Should the Crankpin Be as Large as the Crankshaft

WITH reference to the answer given to question No. 5 "Should the Crankpin Be as Large as the Crankshaft?" in the Nov. 1, 1927, issue, I believe the answer should be more complete, as it might give the impression that bending stresses only will determine the size of the shaft.

The crankshaft is subject to bending stresses owing to the bending moment mentioned, but is also subject to torsional stresses due to a twisting moment which is equal to the load on the crankpin times the length of the crank arm.

Although bending stresses and torsional stresses are working in directions perpendicular to each other, the maximum combined stress will be larger than the maximum bending stress, and this must be taken into consideration when the size of the shaft is to be determined.

York, Pa. T. K. BREDA.

* * * *

Minimum Combustion Air and Maximum CO_2

IN THE **Nov. 8 issue C.** Albert Kulmann gives the following equation for the theoretical maximum content, by volume, of CO_2 in the dry flue gases:

$$CO_2 = 2.4027 \frac{C}{W}$$

in which C is the carbon content of the fuel and W the theoretical air supply in pounds. Although Mr. Kulmann seems to care for great accuracy, as indicated by the fact that he calculates his constants to the fifth place, he uses only the approximate molecular weights. For instance, the expression $H - \frac{O}{8}$ would be, more accurately, $H - \frac{O}{7.94}$ or $H - 0.126 \times O$, since the accurate molecular weight of hydrogen is 2.015, that of oxygen being 32. However, it is quite sufficient to have the constants in three significant figures as the oxygen content of air which is used in calculating the constants, is known to vary between 20.8 and 21 per cent according to location and weather conditions, 20.9 per cent being a fair average.

Furthermore, it would appear that Mr. Kulmann also overlooks the fact that the volume of dry flue gas is not the same as the volume of air supplied, since, in burning, part of the oxygen of the air unites with part of the hydrogen of the fuel to form water vapor, which, upon collecting a dry flue-gas sample, is condensed out. Therefore, as long as the combustion is complete, the volume of dry flue gases is smaller than the volume of combustion air, and the theoretical CO_2 content, as calculated by Mr. Kulmann's equation, is too low.

The correct equation which should be used to calculate the maximum CO_2 content in per cent, reads as follows:

$$CO_2 = \frac{100}{4.78 + \frac{11.2 \times H - 1.4 \times O + 1.8 \times S}{C}}$$

In the example given by Mr. Kulmann (fuel analysis = 67.5 per cent carbon, 5.5 per cent hydrogen, 17.0 per cent oxygen and 1.1 per cent sulphur) he obtained by the use of his equation a maximum CO_2 content of 18.1 per cent. If the foregoing corrected equation is used, we get a maximum CO_2 content of 18.6 per cent. Thus, the error amounts to 0.5 per cent CO_2 in this case, but it will be greater with coal containing a higher proportion of hydrogen.

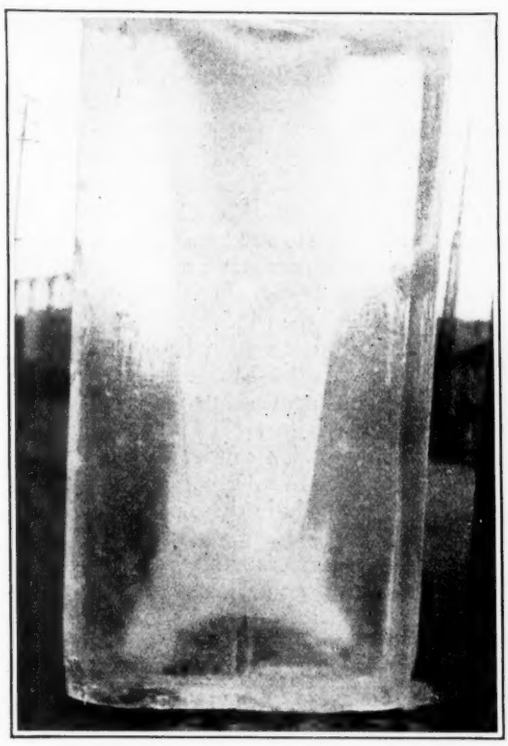
In this connection, it might be mentioned that the sulphur dioxide (SO_2) produced by the combustion is partly absorbed by the condensing moisture of the flue gas when the latter is cooled to room temperature. If a gas sample is analyzed with an Orsat apparatus, a further part is absorbed by the water seal of the Orsat and the remainder is absorbed by the caustic potash solution and therefore indicated as CO_2, all of which tends to indicate too high a CO_2 content. However, since these influences are rather small and their proportions indefinite, they may be neglected. ERIC PICK.

New York City.

* * * *

How Can the Feather Be Eliminated?

WE HAVE an 80-ton raw-water ice plant and use a Graver softener to treat the well water. We use lime and No. 2 Kerno water softener and have had good results, but at present we are having trouble with a deposit at the end of the core, which we call a fish-tail. Our cores are thin, some almost transparent. This fish-tail does not seem to be lime and has a white cloudy color, as shown in the illustration. Often there will be a clear space between the core and the fish-tail.



The ice cake has a distinct fish tail

We use $\frac{1}{4}$-in. agitation pipes 30 in. long and, as far as we know, operate the plant properly. Of course our ice is not all bad; the cake shown was the worst one I could find.

Now I should greatly appreciate it if some refrigerating engineer would suggest how to remedy the trouble.

Lafayette, Ind. THOMAS W. HUDLOW.

What Makes Boilers Drum?

IN CONNECTION with the several letters that have appeared recently in *Power* on "What Makes Boilers Drum," I believe I have solved the puzzle.

I am employed in a plant where there are two 6,000-sq.ft. inclined-tube boilers that drummed when first installed. They drummed so badly at times that it was almost impossible to stay in the boiler room. The boilers are fired by natural-draft traveling grates. We overcame the trouble by placing a ½-in. steam pipe perforated with $\frac{1}{16}$-in. holes under the top part of the grate just inside of the coal gate and allowing steam to blow up through the coal bed. This simple experiment stopped the drumming. It would be of interest to hear how others have overcome this trouble.

OSCAR B. WOODS,
Muncie, Ind. Indiana Steel & Wire Co.

* * * *

Condenser Tube Vibration

AN EDITORIAL in the Oct. 11, 1927, issue on condenser tube vibration asked for further comment on this subject.

All condenser tubes have a natural frequency of vibration, and this depends on the weight of the tubes and the water passing through them, the deflection of the tube and its length between supports. A certain amount of deflection occurs in all tubes and must be kept within reasonable limits by the designer. Trouble has been experienced when there has been a regular pulsation about the plant which was in synchronism with the frequency of vibration of the tubes. When this occurs, the effect on the tubes may be serious, as resonant vibration is set up. Under ordinary circumstances the natural vibration of the tubes does no harm and is impossible to avoid. The steam as it enters the condenser should not impinge directly on the tubes, but should be deflected by means of suitable baffles. Much of the condenser-tube trouble is caused by improper admission of the steam.

In many cases the failure of steam supply pipes has been traced to the vibration caused by the pipe being so supported that its period of vibration was the same as that of the plant. The remedy in these cases has been found in rearranging the piping supports, making the spaces between them either longer or shorter. In many cases vibration set up in a turbine is transmitted to the rest of the plant, although in most cases it is so small as to be negligible, but in the presence of unbalance in the turbine and a bad foundation, the vibration may eventually cause serious damage. Generally, the inherent vibration in a turbine unit does no harm, but if a unit having excessive vibration is operated for any length of time trouble may be expected. Vibration troubles in a turbine plant are rare, and for this reason they are likely to be neglected.

W. E. WARNER.
Brentford, England.

WHILE examining the water valves of an Edwards-type wet vacuum pump, I noticed a condition that may throw some light on condenser tube vibration.

The pump had just been stopped while the turbine it served was running up to speed, with about five pounds inlet pressure, this being a frequent procedure of testing the discharge valves, rod packing, etc., for air leaks.

With the air pump stopped, naturally the vacuum was gradually destroyed, and when atmospheric conditions were reached within the condenser, the pump valves began to flutter, the pulsations being extremely rapid.

Being curious as to the cause, I closed the throttle of the turbine momentarily and the fluttering stopped, only to be resumed when steam was again admitted.

As the steam contained considerable moisture, I first thought the fluttering was caused by minute particles of water exploding, but as the pressure and temperature difference was slight, I do not think this to be the cause.

I at last concluded the valve fluttering to be brought about by impulses of the steam during its passage through the blading, and if so, why couldn't it be imparted to the condenser tubing and cause vibrations under normal operating conditions?

R. S. SPOONER.
New Bedford, Mass.

* * * *

Causes of Dangerous Boiler Deterioration

IN the issue Dec. 13, 1927, H. W. Bannister comments on an article by C. E. Stromeyer—"Causes of Dangerous Boiler Deterioration"—which appeared in the April 26 issue.

Mr. Stromeyer says "scale-forming matter is, or should be, almost entirely removed from the feed, provided the depositing and filtering arrangements are in order." This should be the case in every properly designed and operated water softener. Under such conditions there is no danger that any of the solids left in the water will become crystalline and form scale. Sludge only will be formed.

Regarding the use of barium salts, it may be said that barium chloride has rarely if ever been used practically for the removal of sulphates. On the other hand, with the use of barium carbonate the incrusting and corrosive sulphates are actually removed without the formation of any soluble salts. It may be interesting to add to the analyses given by Mr. Bannister of raw and treated water, the probable combination for the same raw water if treated with lime-barium-carbonate. The analysis of the raw water is repeated:

	Raw Water	Lime Barium Carbonate Soft
Calcium carbonate	16.10	3.5
Calcium sulphate	7.30	...
Magnesium sulphate	6.42	...
Magnesium hydrate	0.00	0.6
Sodium carbonate	0.50	0.5
Sodium sulphate	7.10	7.1
Sodium chloride	1.10	1.1
Colloidal matter (organic)	0.00	...
Total solids	38.52	12.8

In actual practice, even with the lime-barium-carbonate treatment in the cold, the residual carbonate hardness will be somewhat less than given by Mr. Bannister for the lime-soda-ash treatment. But if the rather high residual carbonate hardness for the barium-carbonate treatment is accepted, it will be found that with this process the total solids have been reduced over 69 per cent, whereas with the lime-soda-ash process, the reduction has been only 10.7 per cent and with the colloidal treatment, about 4.3 per cent.

With the lime-soda-ash, as well as the lime-barium-carbonate treatment, only little sludge will be formed as compared with the internal treatment, as stated by Mr. Stromeyer.

K. VON ELTZ, Manager,
New York City. Reisert Automatic Water Purifying Co.

A. H. Markwart Discusses the

Relation of Steam to Water Power*

HYDRO-ELECTRIC equipment has about reached the limit of efficiency and capital costs of projects have an upward trend. Steam plants, on the other hand, have not reached the limit in fuel economy and capital costs have a downward trend by reason of the increasing size of generating units and station capacities. Notwithstanding this condition of affairs, utilization of water power is sound in the broadest sense and hydro development should be encouraged, but cognizance must be taken of the fact that all water power is not susceptible to economic development. It must compete with steam power and should be developed so long as the cost is less or at least no greater than that of obtaining power from fuel.

Combining Existing Supplies With New

What generally must be done hereafter, where additional power is needed, is to combine new with existing supplies to effect a maximum use of both. Such a rule makes for the conservation of our fuel supply and for the realization of the best economic advantages at the time and under the circumstances prevailing.

One of the important fundamentals of power production cost is the relation existing between average and maximum rate at which power is necessary to answer the demand. Costs rise as this ratio of load factor lowers. The capital cost of steam plants at load centers with relatively short transmission, in general, is less than that of hydro plants with long transmission, which occasions lower fixed charges for steam plants. But, giving consideration to the cost of fuel and the relatively high running expense, the cost of steam-generated energy, for 100 per cent load factor, tends to exceed the cost of hydro-generated energy.

On the other hand, for low load factors, on account of the greater amount of hydro capital which is unproductively employed, and because of the small quantity of fuel required to generate the relatively small number of kilowatt-hours which obtain with low load factors, the cost of hydro-generated energy tends to exceed the cost of steam-generated energy. A low load factor and cheap fuel, then, suggests steam-plant development, whereas a high load factor and expensive fuel makes hydro development attractive. In either case the load factor has a determining effect on the cost of power whether it be supplied by steam plants, by hydro plants, or by a combination of the two.

Capital Cost per Kilowatt

The capital cost per kilowatt of delivered peak of hydro plants varies greatly and will range from perhaps a minimum of $150 under favorable conditions to $400 or more, depending largely upon storage requirements and distance of transmission. On the other hand, the capital cost per kilowatt of delivered peak of steam plants does not vary greatly, the range being from perhaps $85 minimum to $125 maximum, so that for the purposes of this discussion $100 may be assumed as a reasonable standard steam plant cost.

> WITH hydro equipment nearing maximum efficiency and development costs increasing, and marked improvement in steam plant economies, it would appear that ultimate development of water power must involve the use of a proportion of steam power. In fact, it is quite probable that a combination system will generate at a lower cost than either steam or hydro alone. The relation between the two power sources involves many factors brought out in the economic study presented in this article.

The annual cost of steam plants, including the cost of "no load" fuel, but not including the cost of energy fuel, expressed as a percentage of the capital cost thereof, is almost invariably greater than the annual cost of hydro plants similarly expressed, by approximately 50 per cent. It is therefore possible to spend 50 per cent more capital on a hydro plant to give the same annual cost of power from a steam plant at zero load factor.

As the load factor rises, thereby causing the annual cost of steam power to rise, because fuel for energy is proportionately used, the cost of hydro power may be kept equal to the cost of steam power at a given load factor by expending no greater amount of hydro capital per kilowatt than that which would equal the capital value of the annual cost of steam power including the cost of all fuel, capitalized at the annual percentage cost of hydro power.

From the foregoing general statements Mr. Markwart establishes the following principles:

1. When primary hydro power is available to suit the system load factor, and when the capital cost of a kilowatt of hydro is less than the capital value of the annual cost of a kilowatt of steam, including the no-load fuel, but not including the energy fuel, capitalized at the annual percentage cost of a kilowatt of hydro, it will be cheaper to supply all system power from hydro developments.

2. When the cost of a kilowatt-year of hydro power is greater than that of steam power at some load factor less than the system load factor, it often will be economic in a base load primary hydro supply to furnish the system load from both hydro and steam, using steam on the top, and the hydro on the bottom at load factors lower and higher than the given system load factor which would respectively obtain for the steam and the hydro.

3. When the cost of a kilowatt year of steam power at 100 per cent load factor is less than that of hydro power, obviously steam power will always be cheaper than hydro power at any system load factor.

4a. When hydro power is available for peak from pondage, but not for energy in an amount sufficient to meet the demand for energy at the given system load factor, and when this hydro peak can be furnished at a capital cost equal to or less than the capital value of the annual cost of equivalent steam power without energy fuel, capitalized at the annual percentage cost of the hydro plant, it will be economic in a base-load steam supply to supply the system peak with such hydro power. The amount of this peak power will be determined wholly by the ability of the hydro plant to furnish the kilowatt-hours required above the kilowatt load carried by the steam plant.

4b. If at times of the year secondary energy is available from the run-of-river flow from such a hydro plant, this energy may be employed to reduce the base load energy fuel consumption, thus producing correspondingly further

*A summary of the ideas of Mr. Markwart, vice-president in charge of engineering, of the Pacific Gas & Electric Company, on the relation of steam to hydro power, as expressed before a number of the local engineering associations on the Pacific Coast and in a general treatise on "Power in California," appearing in a recent issue of the *Journal of the Franklin Institute*.

economy which will permit the expenditure of additional hydro capital, amounting to the capital value of the fuel saved when capitalized at the annual percentage cost of the hydro plant.

To illustrate these principles with particular reference to the first three, an economic study was developed to ascertain the cost of delivering 400,000 kw. at load centers under two load factor conditions, one for a regional supply, for which a 65 per cent load factor is possible, and the other for a metropolitan supply at the lower load factor of 45 per cent.

Fig. 1 represents a composite daily load curve for a 65 per cent load factor, so constructed that 365 of these curves would contain with a great degree of accuracy the total kilowatt-hours for the year. Similarly, Fig. 2 is a corresponding composite curve for a 45 per cent load factor. Both curves are constructed on the basis of a peak of 400,000 kw., therefore the annual kilowatt-hours relating to them would be 365 times the kilowatt-hours lying in each curve, that is, 260,000 kw. for 8,760 hours, or 2,277,600,000 kw.-hr., for the 65 per cent load factor; and 180,000 kw. for 8,760 hours or 1,576,800,000 kw.-hr. for the 45 per cent load factor.

From these curves were determined the load factors and kilowatt-hours from base and peak for various percentages of the system peak from 100 per cent to zero, as given to the left of the curves. The 65 per cent curve indicates, for instance, that if 60 per cent of the annual peak from base is carried on hydro plants, 83.63 per cent of the required energy will be supplied from such hydro plants on a load factor of 90.8 per cent. If the remaining 40 per cent of the peak is carried on steam plants, the balance, or 16.38 per cent of the required energy, will be supplied by the steam plants on a load factor of 26.7 per cent. Similarly, with the 45 per cent curve, when carrying the same percentages of peak on hydro and steam, 95.43 per cent of the required energy will be supplied from the hydro plants on a load factor of 71.3 per cent, and the remainder of the energy, or 4.57 per cent, will be supplied by the steam plants on a load factor of 5.1 per cent.

In the study the capital cost of hydro, including transmission and terminal substations, was taken as $150, $200, $300 and $400 per kilowatt of delivered peak, these figures also including the cost of storage works to effect stream regulation and to carry over a water supply for dry years, but not spare capacity. To attain the annual costs for depreciation, operation and maintenance hereafter used, it was assumed that the hydro plant throughout was constructed in accordance with the best modern practice.

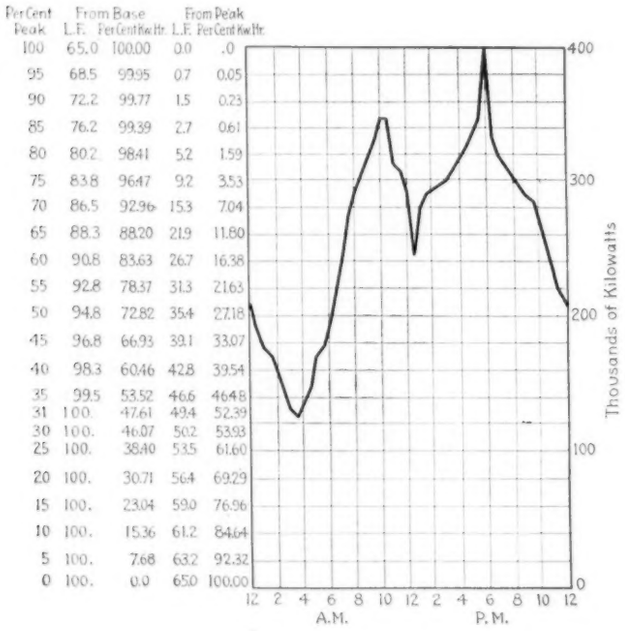


Fig. 1—Composite daily load curve at 65 per cent load factor

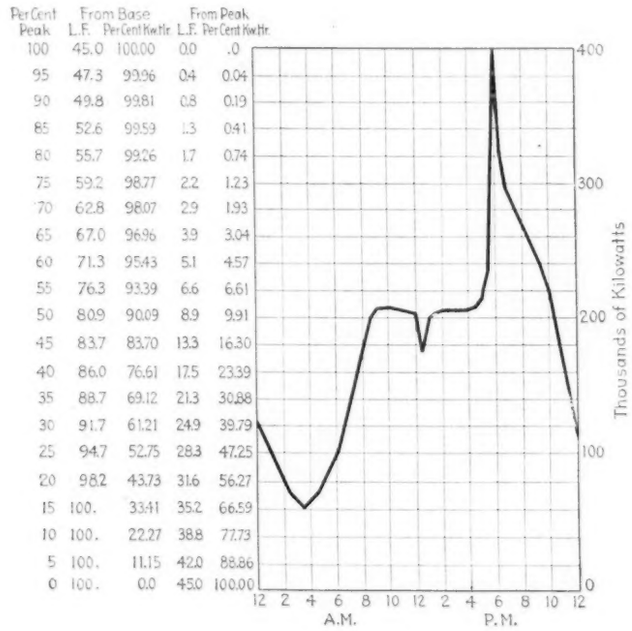


Fig. 2—Composite daily load curve at 45 per cent load factor

Steam-Plant Cost

Steam-plant capital cost was taken at $100 per kilowatt plus a capital cost for back transmission for the 65 per cent load factor load, varying from $33 per kw. for 100 per cent steam supply to nothing for a 50 per cent steam supply; and $100 per kw. for the 45 per cent load factor load, no back transmission being considered in this case because it was assumed that a load of 45 per cent load factor, in the nature of things would be exclusively metropolitan.

Annual costs, on the basis of low-maintenance hydro construction and modern steam plants, were derived by applying to the capital the following annual percentages:

	Hydro Delivered	Steam	Steam Power Transmission
Return	8	8	8
Depreciation	1	3	1
Operation and maintenance	1.5	3	1.5
Total percentage of capital	10.5	14	10.5

In addition the cost of 1¼ bbl. of oil per kilowatt per year was included with the annual steam-plant cost.

No losses were assumed in computing the volume of hydro capital for the reason that the unit capital costs are considered as those which would effect the delivery of one kilowatt at the load center. With the steam in the 65 per cent load factor case, however, the capital and fuel consumption was computed on the basis of a 3 per cent loss for steam loads of 100 per cent, to zero loss for steam loads of 50 per cent.

A barrel of oil was considered to contain approximately 6,250,000 heat units and the energy yield was taken at 450 kw.-hr. when burned in modern high-pressure, high-temperature steam generating plants, after the "no-load" fuel has been supplied. In the economic study, oil prices were chosen at $0.50, $0.75, $1, $2 and $3 per barrel, which is equivalent to $2, $3, $4, $8 and $12 coal at 12,500 B.t.u. per pound. Under the assumption of 450 kw.-hr. per barrel, plus the no-load fuel of 1¼ bbl. per kw.-yr., the steam plant economy would be 14,770 B.t.u. per kw.-hr., at 100 per cent load factor.

The type of steam plants considered were those employing 450 lb. boiler pressure with a total steam temperature of 725 deg. F. The boilers would be equipped with furnace water walls and

operated up to 350 to 400 per cent of rating and have air heaters installed to maintain good efficiency at this loading. The turbine units in the plants would be of a unit capacity of 30,000 kw., or larger, with steam extracted for feed water heating and evaporation of the makeup water. All auxiliaries would be electrically driven.

The annual cost of serving the total load was determined for different apportionments of the peak between steam and hydro, with zero per cent on steam and advancing in 10 per cent units to 100 per cent. The total cost of fuel was ascertained from the information given on the load curve. The whole was plotted as a family of curves for the different capital costs of hydro and the different fuel prices for the two load factor conditions, as indicated in Figs. 3 and 4. These curves indicate the total capital requirement, the annual cost, the kilowatt-hour cost, and the load factor for the steam and hydro plants respectively for all the chosen unit capital costs and fuel prices, for different percentages of the peak which are carried by steam from zero per cent to 100 per cent.

For instance, in Fig. 3, when the capital cost of hydro is $300 per kw., and the cost of oil is $2 per bbl., the cheapest way to serve the 65 per cent load factor load is to deliver 300,000 kw. of hydro and 100,000 kw. of steam power. To do this $100,000,000 of capital will be required. The combined annual cost will be $11,500,000 and the cost per kilowatt-hour slightly above 5.2 mills. The hydro will operate at 84 per cent load factor and the steam at 9 per cent (see Fig. 1).

Turning to the other set of curves, in Fig. 4, it will be observed under the same conditions of hydro capital cost and fuel prices, that the cheapest way to serve the 45 per cent load factor load is to deliver 200,000 kw. of hydro power and 200,000 kw. of steam power. In this case the required capital is $80,000,000, the annual cost is $10,300,000 and the cost per kilowatt-hour is 6.5 mills. The hydro will operate at 81 per cent load factor and the steam at 10 per cent load factor.

In other respects the curves are illuminating. With hydro capital at $150 and oil at $1 per barrel or under, the load may be carried exclusively on hydro, or up to 20 per cent on steam for 65 per cent load factor, and up to perhaps 40 per cent for the 45 per cent load factor, without material change in the economy. On the other hand, with hydro at $400 per kw., and oil at $1 a barrel, the 65 per cent load factor load may be carried 100 per cent down to 60 per cent on steam at practically the same economy. For oil prices less than $1 it would be economical to carry all the load on steam; with $2 oil, from 30 to 50 per cent; and with $3 oil, 25 per cent. In the 45 per cent load factor case, however, it would be economical to carry all the load on steam with oil at $1 a barrel and under; from 50 to 70 per cent with $2 oil; and 50 per cent with $3 oil.

While the study may not be quantitatively perfect, it develops the economic certainty that at times the cost of power will be a minimum with joint steam and hydro operation and is fairly accurate in indicating the direction in which economy lies; or, in other words, it points out the path to maximum economy in power generation when both fuel and water power are available, although either one can be used exclusively at a reasonable cost, or at a cost less than that obtaining with the other.

Thus the ultimate development of our water powers, which are becoming more expensive, involves the use of a proportion of steam, if maximum use is to be made of them, and the developments are to be profitable. Among other things it will be necessary to look to the general situation of higher hydro and lower steam costs to the end that there will be a continuance of low priced power.

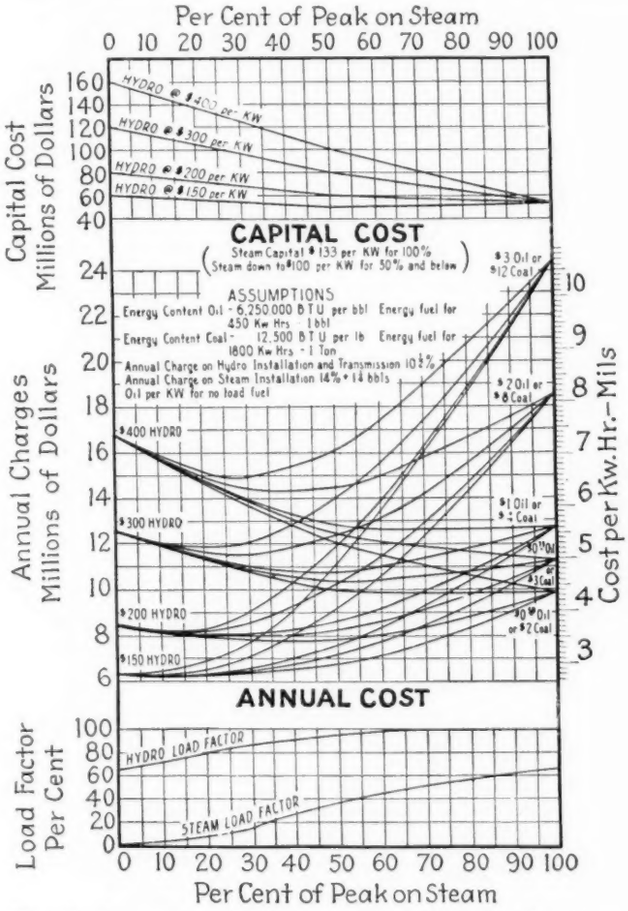
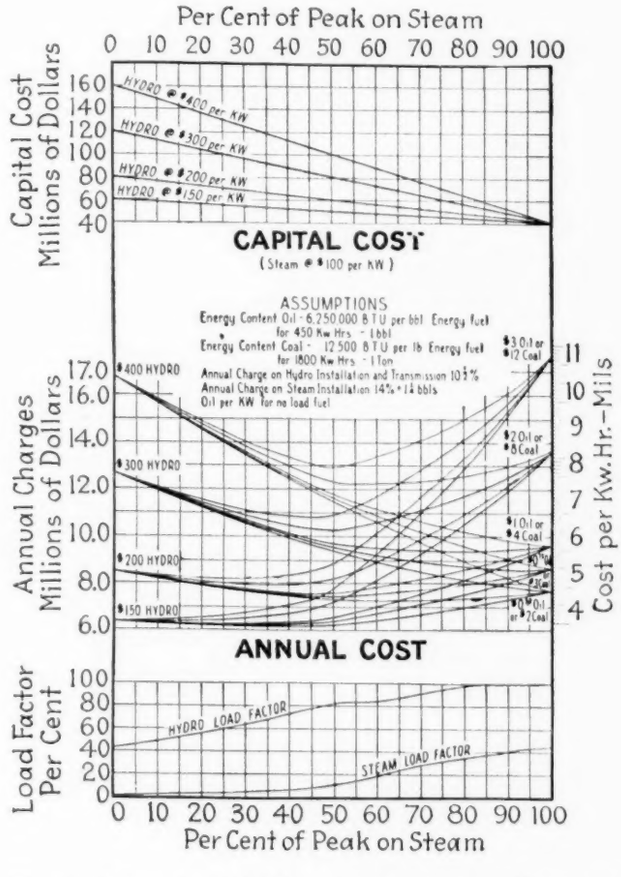

Per Cent of Peak on Steam
Capital Cost Millions of Dollars
HYDRO @ $400 per KW
HYDRO @ $300 per KW
HYDRO @ $200 per KW
HYDRO @ $150 per KW
CAPITAL COST
Steam Capital $133 per KW for 100% Steam down to $100 per KW for 50% and below
ASSUMPTIONS
Energy Content Oil - 6,250,000 B.T.U. per bbl Energy fuel for 450 Kw Hrs. - 1 bbl
Energy Content Coal - 12,500 B.T.U. per lb Energy fuel for 1800 Kw Hrs. - 1 Ton
Annual Charge on Hydro Installation and Transmission 10½%
Annual Charge on Steam Installation 14% + 14 bbls Oil per KW for no load fuel
$3 Oil or $12 Coal
$2 Oil or $8 Coal
$1 Oil or $4 Coal
$400 HYDRO
$300 HYDRO
$200 HYDRO
$150 HYDRO
Annual Charges Millions of Dollars
Cost per Kw.Hr.-Mills
ANNUAL COST
Load Factor Per Cent
HYDRO LOAD FACTOR
STEAM LOAD FACTOR

Fig. 3—Curves for 400,000-kw. peak system at 65 per cent load factor, with hydro assumed as base load


Per Cent of Peak on Steam
Capital Cost Millions of Dollars
HYDRO @ $400 per KW
HYDRO @ $300 per KW
HYDRO @ $200 per KW
HYDRO @ $150 per KW
CAPITAL COST
(Steam @ $100 per KW)
ASSUMPTIONS
Energy Content Oil - 6,250,000 B.T.U. per bbl Energy fuel for 450 Kw Hrs. - 1 bbl
Energy Content Coal - 12,500 B.T.U. per lb Energy fuel for 1800 Kw Hrs. - 1 Ton
Annual Charge on Hydro Installation and Transmission 10½%
Annual Charge on Steam Installation 14% + 14 bbls Oil per KW for no load fuel
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$2 Oil or $8 Coal
$1 Oil or $4 Coal
$400 HYDRO
$300 HYDRO
$200 HYDRO
$150 HYDRO
Annual Charges Millions of Dollars
Cost per Kw.Hr.-Mills
ANNUAL COST
Load Factor Per Cent
HYDRO LOAD FACTOR
STEAM LOAD FACTOR

Fig. 4—Curves for 400,000-kw. peak system at 45 per cent load factor, with hydro assumed as base load

NEWS *of the* FIELD

Third Annual Mid-West Power Conference To Appeal to Power Engineers

Plans for Seven Sessions at Chicago Covering Problems of General Interest—Annual Banquet an Outstanding Feature—Strong Support by Societies

TO COVER the broader phases of the power problems and to present them in such a way as to appeal more directly to the operating and technical engineers as well as to drive home to consumers the epic story of power, is in brief the purpose of the Third Annual Mid-West Power Conference to be held in Chicago from Feb. 14 to 17, inclusive.

The conference has been divided into seven sessions, each covering a specific problem of general interest and importance. The first session will be devoted to social and technical aspects of power development. An entire day will be given up to the relation of power development to flood control and other river problems. Speakers of national repute will discuss the power and allied problems of the Mississippi Valley, the Colorado River and of the St. Lawrence River. On the third day a session on the economics of power stations and a luncheon devoted to electrical transmission, will interest industrial and public utility representatives. At the final session of the meeting the power station program will be continued with papers on combustion control, steam reheating and embrittlement of boiler plate. All in all, the program is widely diversified and there should be something of interest to all branches of the power field.

INSPECTION TRIPS OF INTEREST

Headquarters will be at the Hotel Stevens. Following the lead of a year ago, the annual banquet will be made an outstanding feature. One afternoon will be devoted to inspection trips. Obviously, the program has been arranged so that there will be plenty of time available to spend at the Power Show held simultaneously at the Coliseum. Buses will be provided on regular schedule to cover the short distance between conference and show headquarters.

The Mid-West Conference is sponsored and indorsed by the local sections or regional divisions of the American Institute of Electrical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining & Metallurgical Engineers, National Electric Light Association, Western Society of Engineers, National Safety Council, American Society of Heating & Ventilating Engineers and the American Society of Refrigerating Engineers. The conference officers are: Major Rufus W. Putnam, president; Alec D. Bailey, vice-president; G. E. Pfisterer, secretary, and K. A. Auty, treasurer, while the general conference committee is made up of two representatives from each of the foregoing societies. A complete outline of the conference program follows:

TUESDAY, FEBRUARY 14, 1928

8:30 a.m.—Registration, Hotel Stevens, Eighth St. and Michigan Ave.

10:30 a.m.—Address of welcome, Sewell Avery, president, Commercial Club of Chicago; Address by Major Rufus W. Putnam, chairman of Power Conference.

11:00 a.m.—Address, "Power, the Background of Today's Civilization," by Glenn Frank, President, University of Wisconsin.

2:00 p.m.—General Session—"Power's Accomplishments in Factory and Home."

1. "America's Part in the Romance of Power," by W. A. Durgin, Dir. Pub. Relations, Commonwealth Edison Co.
2. "Drudgery Banished from the Home," by Mrs. J. D. Sherman, President, Gen'l Federation of Women's Clubs, Washington, D. C.,
3. "How to Make the Burden Bearer Bear the Burden," by Burke Corcoran, secy. Elec. Assn. of Chicago.

WEDNESDAY, FEBRUARY 15

9:30 a.m.—General Subject: "The Relation of Power Development to Flood Control and other River Problems."

1. "The General Flood Control Problems on the Mississippi System," by Gen. Edgar Jadwin, Washington, D. C.
2. "Problems of Storage for Flood Control and for Power Development," by Prof. D. W. Mead, Madison, Wis.
3. "Irrigation and Power Development Problems on the Colorado River," by Col. William Kelly, Buffalo, N. Y.

2:00 p.m.—4. "The Tennessee River Survey," By Maj. L. H. Watkins.

5. "Navigation and Power Development on the St. Lawrence River," by E. A. Forward, Cons. Engr., Montreal, Canada.
6. "The Combined Use of Water and Steam Power," by F. A. Allner, Gen'l. Supt., Penna. Water & Power Co., Baltimore, Md.
7. "Progress and Trend in Hydraulic Power Developments," by H. A. Hageman, Chief Hyd. Engr., Stone & Webster.

7:00 p.m. — Annual Banquet — Hotel Stevens. Program and general arrangements to be announced later.

THURSDAY, FEBRUARY 16

9:45 a.m. — Session: "Economics of Power Stations."

1. "Capital Costs with Relation to Economy of Central Stations," by Alex Dow, President, Detroit Edison Co.
2. "High-Pressure Operation," by G. A. Orrok, Con. Engr., New York City.
3. "Trend and Development in Steam Generation," by Thos. E. Murray, The T. E. M. Inc., New York City.

1:00 p.m.—Luncheon Symposium:

1. "Underground Transmission Developments and the General Effect Upon Reliability of Service," by H. B. Gear, Commonwealth Edison Co.
2. "Overhead Transmissions," by G. F. Humphrey, West Penn Power Co.
3. "Equipment for Power Transmission," by A. C. Montieth, Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.

2:00 p.m.—Inspection trips for the afternoon to be announced later.

FRIDAY, FEBRUARY 17

9:45 a.m. — Session: "Economics of Power Stations."

1. "Combustion Control in Industrial Plants," by T. A. Peebles, Hagan Corporation.
2. "Combustion Control in Central Stations," by Chas. H. Smoot, Smoot Engineering Company, New York City.
3. "The Effect of Steam Reheating, Stage Feed Water Heating and Boiler Reheating on Steam Turbine Practice and Development," by Edward Brown, Allis Chalmers Manufacturing Co., Milwaukee.
4. "Embrittlement of Boiler Plate," by Prof. S. W. Parr and F. C. Straub, University of Illinois.

N.E.L.A. Sees New Records in Electric Industry in 1928

Consistent expansion has continued during 1927 along those lines on which the electric light and power industry of the country has been working. Figures for the year just made available by the National Electric Light Association tend to show that earnings have increased, in spite of a general tendency throughout the country toward lower rates to consumers, and in the face of definite diminution in industrial activity in some sections of the country.

Indications are that the growth of the industry in 1928 will set new high marks in generation and earnings. The investment of the industry in plant and equipment at the end of 1927 is approximately $8,700,000,000, and the gross income for the year approximates $1,700,000,000. The total taxes paid—including federal, state, county, local and special—amount to more than $150,000,000.

The total output of electricity from these operating utilities reached a production of 79,000,000,000 kw.-hr. representing a 7½ per cent increase over 1926. This falls but little below the rate of increase that has been experienced in recent years. During 1927 there was an approximate addition of 10 per cent in plant and equipment. The total production of electricity in 1926 was 74,000,000,000 kw.-hr., and it is expected that the figure for 1928 will show a total of 83,000,000,000 kilowatt-hours.

The spread of the economic movement toward interconnection is referred to as an important contributing factor in allowing earnings to be maintained and even slightly increased in spite of the slowing up of industrial activity due to the floods in the Mississippi Valley and New England, the prolonged soft coal strike and in some sections a diminution in activity that is reflected in employment figures.

Sales of electricity were maintained at nearly the normal rate of growth although the sales of commercial and industrial power did not come up to the normal growth of previous years. This, however, gives no serious hint of diminished production of any considerable proportion.

Utilities Power & Light Buys Two Iowa Companies

The Central States Power & Light Corporation, of Davenport, Iowa, and the Federal Public Utilities Company, of Dubuque, Iowa, are to be taken over by the Utilities Power & Light Company of New York.

Transfer of the first company was completed recently, and negotiations on the second acquisition will be completed shortly. The Central States Utilities company, a subsidiary of the New York concern, will become owner of the Davenport group of companies, which operate in 187 towns in Iowa, Missouri, North Dakota, Oklahoma and Arkansas.

The Federal Public Utilities holdings extend in all those states and Louisiana, Alabama, Michigan, Minnesota and Canada, as well. Officers of the Central States Power were: Thomas J. Walsh, president; Ray G. Cundy, E. C. Mueller and W. C. Tegtmeier, vice-presidents; Ray Nyemaster, treasurer, and Charles H. Murray, secretary.

A.S.R.E. Appoints D. L. Fiske as Secretary

The council of the American Society of Refrigerating Engineers held its first meeting under the administration of President G. B. Bright on Dec. 7, 1927, appointing David L. Fiske as secretary for the coming year. Mr. Fiske has been associated with the A.S.R.E. during the past year as editor of *Refrigerating Engineering*.

Mr. Fiske's experience with the refrigeration field has been mainly confirmed to research. He was connected with the engineering experiment station of the University of Illinois as research man for two years in refrigeration and for three in railway mechanical engineering. His practical experience with refrigeration included service with Wilson & Company, packers, as draftsman, and testing and erecting work with the McClellan Refrigerating Company.

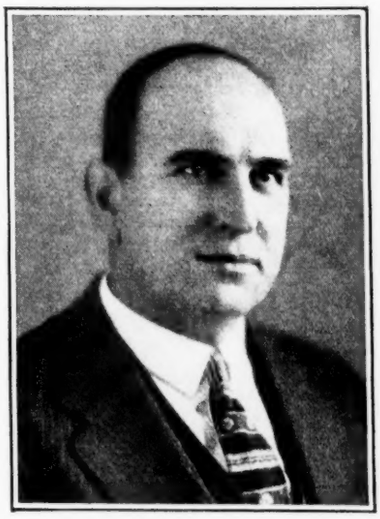
Mr. Fiske is a graduate of the Massachusetts Institute of Technology, class of 1920, in mechanical engineering. At Illinois he completed two years of graduate study in thermodynamics. He is the author of the present table of SO_2 properties.

David L. Fiske

George B. Bright has been connected with the field of refrigeration since the age of 13, when he "toted" ice in Staunton, Va., from the old ice plant and grist mill of J. F. Tannehill & Company.

Through three managements Mr. Bright worked at the Staunton plant, doing special work for the Frick Company in 1904, which he joined in 1905 as a machinist and erector on open-frame vertical compressors.

From Chicago, where he had gone in 1906, he went to Detroit, where Charles Dean, Sr., of the Pittmans & Dean Co., natural ice dealers, became interested in his ideas for raw-water ice. At the request of Mr. Dean he built several plants, and introduced raw-water ice into Detroit. Mr. Bright founded the Detroit Ice Machine Company in 1916 in order to divorce this work from his private engineering business.



George B. Bright

In the manufacture of labor-saving devices Mr. Bright has had much success. In February, 1922, the design for the first "can basket" used in this country was sufficiently perfected for its incorporation into the Beaubien Ice Company plant in Detroit.

To Discuss Gas as Industrial and Domestic Fuel

A meeting to discuss the utilization of gas as an industrial fuel under the auspices of the Engineers Club of Philadelphia with the co-operation of the American Gas Association, Pennsylvania Gas Association, Philadelphia Chapter of the American Society for Steel Treating, and the American Society of Heating & Ventilating Engineers, will be held at the Engineers' Club, Philadelphia, at 7 o'clock, Jan. 17.

An informal dinner at 6 o'clock has been arranged. Oscar H. Fogg, vice-president of the Consolidated Gas Company, New York, will emphasize advantages in the use of gas for industrial heating, problems incurred, co-operation with industries, and future possibilities. George E. Whitwell, general manager, Philadelphia Company, Pittsburgh, will speak on the problems involved in domestic heating and other uses. A general discussion will follow.

Engineering Council Urges Congress to Survey Water Resources

Seeks Inventory Directed by Geological Survey to Study Basic Facts on Flood Discharges, and the Design, Construction and Operation of Works Utilizing Surface Waters

TO AID in solving the problem of flood control, the American Engineering Council will urge Congress to authorize an inventory of the water resources of the United States under the direction of the Geological Survey, it is announced by the president of the Council, Dean Dexter S. Kimball, of Cornell University.

Only through the assembling of complete data can safety of life and property be assured, according to Dean Kimball, who said that the question would be discussed at the annual meeting of the Council to be held in Washington on Jan. 10 and 11. Dean Kimball's statement, in part, follows:

"The large loss of life and property caused during 1927 by unprecedented floods in the Mississippi Valley, New England and other parts of the country, has naturally led to serious consideration of means for the more effective control and utilization of surface water.

Broad Range of Study

"In such control and utilization engineers and others have been greatly handicapped by lack of basic facts, especially with respect to the magnitude of flood discharges and the average interval of time between floods of any given magnitude. There has been, therefore, evident need for more information as to the total quantity of run-off and the times and quantities of discharge at maximum, mean and minimum stages. Such information must be collected over a period of several years since it is not possible adequately to determine the extremes of discharge by other means.

"The same information is needed also in connection with the design, construction, operation and administration of all works for utilizing the surface waters of the country.

To Seek Rapid Unbiased Data

"The American Engineering Council has therefore brought the situation to the attention of Congress, and, on Dec. 22, Congressman Newton introduced in the House of Representatives a bill providing for an inventory of the water resources of the United States.

"Under the terms of this bill the United States Geological Survey is authorized, in co-operation with federal, state and other governmental agencies, or with private enterprises developing or using water under governmental regulation, to collect the necessary information and prepare an inventory of the nation's water resources.

"The data are to be published as rapidly as practicable for use by the general public in the economic development, operation, administration and regulation of the rivers of the country.

"The United States Geological Survey has been selected for this task because it is the authorized and recognized federal agency for collecting and publishing data in regard to natural resources.

"Moreover, it is primarily a research agency and is not directly interested in constructing or administering specific projects or specific types of projects. The general public has therefore confidence that the results of its work will be non-partisan and unbiased.

Well Equipped for Task

"The Survey is well equipped for this task because of its trained personnel and previous record of service. It has developed the instruments and methods now accepted as standard throughout the world, has a force of engineers especially trained for this class of work and is organized for country-wide activities through the agency of 25 district offices each of which is under the direction of an experienced district engineer.

"By use of relatively small annual appropriations it has collected and published, over a period of forty years, in co-operation with state and other agencies, much information in regard to the nation's water supplies.

Findings To Be Made Available

"With the rapid growth of the country in population and industry the demand for facts relating to rivers has, however, increased much faster than the information could be collected by means of available funds.

"It is the intent of the Newton bill, therefore, to insure that in future the essential data in regard to our rivers shall be collected and made available as fast as needed for economic development, in order that our water resources may be developed in an orderly manner and serious and expensive mistakes may be avoided.

"The data thus made available will be utilized by engineers, financiers, courts and others in connection with the design, construction and administration of projects for domestic, municipal and industrial water supplies, irrigation, water power and the control of floods. By no other practicable means can safe and sane use of this great natural resource be assured."

Under Engineering Supervision

Reorganization of the Department of the Interior to accomplish centralization under engineering supervision of the immense public works functions of the government will also be discussed at the Council's meeting, when a program of action for 1928 will be adopted.

Sir Esme Howard, British Ambassador, will be the chief speaker at the annual dinner of the Council on the evening of January 10.

New Design Generating Equipment for Six U. S. Cruisers

A new design of turbine-generating equipment, with turbines operating at 10,000 r.p.m., driving the generators through gears at 1,200 r.p.m., combining features of light weight and compact design, will be installed in six Light Cruisers, Nos. 24, 25, 26, 27, 30, and 31, now being built by the United States Navy. These cruisers are the first ships projected since the Limitation of Arms Conference in 1921.

A total of 24 turbine-generator sets is called for, four sets to be installed in each vessel. Each set is rated 250 kw., and the electricity generated will be used for furnishing light and auxiliary power. The 24 sets are being built by the General Electric Company.

The design of this equipment is a direct result of the 1921 Limitation of Arms Conference. As any cruisers that might be built during the life of the treaty must not exceed a displacement weight of 10,000 tons, it was imperative that the present cruisers must be designed to obtain the maximum amount of cruising radius, the highest speed and the greatest fighting power.

With the total tonnage limited, all the elements of the vessels, therefore, had to be designed to have the least possible weight. In the case of the auxiliary turbine-generator sets, the requirements were particularly severe, not only because of weight, but also because the economy of the units affects the cruising radius o fthe vessel.

The foundation, instead of being the orthodox type of cast steel, is designed as part of the ship's structure, thereby saving a great amount of weight.

Engineering Education Fund Raised for Inquiry

The Society for the Promotion of Engineering Education has announced through W. E. Wickenden, director of investigation and co-ordination, a special fund of $30,000 provided by several educational institutions and the Carnegie Corporation to investigate the need of industry in technical preparation in the colleges.

The inquiry is to be directed to indicate the character and extent of the need for education more advanced than that of secondary schools; affording preparation for technical and supervisory services rather than training in skilled trades; briefer, more intensive and more direct, more technical, and not leading to an academic degree.

Installs Britain's Largest Brush-Ljungstrom Turbine

The St. Pancras generating station, one of the most important central generating plants supplying the City of London, has just put into operation the largest Brush-Ljungstrom turbine-generator set in England.

This set has an output of 10,000 kw. at its most economical load, generates at 5,050-5,300 volts, and receives steam at 200 lb. per sq.in. at the top valve, superheated to a total temperature of 688 deg. F. The set is capable of developing an overload of 25 per cent continuously.

As is well known, this turbine is of the reaction type and owes its high efficiency principally to the use of two rotors revolving in opposite directions with a relative speed equal to twice the running speed. The blade rings are mounted on disks in such a manner that the rings of one disk lie between the rings of the other disk. The steam is admitted to the center of the blade system and expands radially outward, so that the casing of the turbine is in contact with low-pressure steam at a temperature corresponding with the vacuum at the exhaust flange.

Follows Temperature Variations

The light weight of the Ljungstrom turbine, such as that installed at St. Pancras, insures that the whole of the material follows quickly any variations in temperature, and owing to the interposition of the blade rings of the two disks, contiguous portions of the two halves of the blade system, revolving in opposite directions, are subjected to nearly the same temperature, pressure and centrifugal stress, so that there is practically no tendency for the clearances to alter under any conditions of loading. An important feature of the design is the use of rings of dumb-bell section between connected parts which are subject to temperature variations. This construction permits the parts to expand and contract freely under the influence of temperature changes without distortion or the introduction of stresses into the material.

The total capacity of the boiler plant at St. Pancras is now 440,000 lb. of steam per hour at 230 lb. pressure, superheated to 700 deg. F. Of the eight boilers, four are fired by mechanical stokers and four by the Lopulco system of pulverized fuel.

Many Topics for Michigan Engineers Conference

Engineers from various sections of Michigan and contiguous territory, representing the several branches of the profession, will take part in the Michigan Engineering Conference at the Hotel Statler, Detroit, Jan. 27 and 28.

The program carries a broad range of interest, embracing talks on commercial aviation, electrification of railways, relation of the engineer to management, discussed by John Lyle Harrington, consulting engineer, Kansas City, Mo., science with art in lighting, welding, presented by Prof. Comfort A. Adams, Harvard University, city planning and water front development, Mississippi River problem, and the x-rays as an engineering tool. C. F. Hirschfeld, chief of the research department of the Detroit Edison Company, will speak on "Two Blades Where But One Grew Before." A banquet will be held Friday evening.

Philadelphia A.I.S.E.E. Slate "Switchboard Symposium"

Members of the Philadelphia section of the Association of Iron and Steel Electrical Engineers are looking forward with much interest to the coming technical session at the Engineers' Club, 2:30 p.m. Saturday, Jan. 7, which will feature a "Switchboard Symposium."

Four short talks will be contributed by well-known engineers, who will discuss the general topic from as many aspects. P. T. Vanderwaart, electrical engineer, New Jersey Zinc Company, Palmerton, Pa., will take charge of the opening meeting on "Superpower and Its Effects on Existing Equipment."

In his talk on "Obsolescence of Switching Equipment Due to Increased Service Capacity," W. H. Andrew, switchboard engineer, Westinghouse Electric & Manufacturing Company, will describe some actual failures of switching equipment which have caused complete plant shutdowns, showing also that some relatively large losses in production and valuable equipment can be saved by spending money to replace apparatus which may be unsafe for the duty of short-circuit and transient conditions.

"The Effect of Transient Phenomena on the Selection of Electrical Equipment," by E. G. Merrick, industrial engineering department of the General Electric Company, will deal with certain of the transient phenomena usually encountered in electrical installations. Examples will be given to illustrate the methods used to predetermine their magnitude and the selection of equipment adequate to withstand the duty imposed. Lantern slides will be shown to indicate the manner in which overtaxed apparatus may fail.

The talk on "The Safety and Continuity of Service Angle," by E. O. Macferran, superintendent of substations, Philadelphia Electric Company, will cover such features as isolating and enclosing current carrying parts, grounding, precautions taken to prevent operation of equipment in wrong sequence, safety rules for operation, protective relays, relay operation annunciators, and other aids to safeguard operation from the viewpoint of safety to life and that of continuous service and quick restoration of service after an interruption.

Tacoma Plans for 45,000 Hp. Additional Unit

Tacoma, Wash., is planning for more power. Less than two years after the completion of the first plant of the Cushman project, bringing in 50,000 hp. for the municipal light and power system, the city is starting another 45,000 hp. development.

It will be needed, if the present growth of the city's power load continues, to avoid a power shortage in the winter of 1930-31, and present indications are that the city will have to generate some power again with steam or buy power in the winter of 1929-1930, according to a statement given the city council by Commissioner Ira S. Davisson of the public utilities department.

The second unit of 45,000 hp. is half the amount of power which it is planned to develop at sea level on Hood canal, near Potlach, by using over again the water passing through the wheels of the first plant. The canyon of the north fork of the Skokomish River is to be dammed again about 1½ miles below the present dam to raise the water to the level of the discharge from the first power house. Then it must be transmitted to the vicinity of Hood canal through a tunnel, less than 2½ miles long.

It will take between two and one-half and three years to complete the second plant, Commissioner Davisson told the council. The first step will include drilling and making other tests of dam site, compiling all necessary data and designing the dam, tunnel and power house. This work will take the greater part of next year, it is expected.

J. L. Stannard, chief engineer for the first unit, will continue as chief engineer for the second development, work, assisted by Alvin F. Darland, superintendent of electrical design and construction, and J. V. Gongwer, structural engineer.

Personal Mention

Ray V. Major has entered the service of the San Diego Consolidated Gas & Electric Company as test engineer at Station B.

George B. Johns, who has been with the Union Gas & Electric Company, Cincinnati, Ohio, has now become assistant electrical engineer for the Associated Gas & Electric Company, Oneonta, N. Y.

R. G. Macdonald, formerly of the market research staff of the McGraw-Hill Publishing Company, Inc., and contributor to *Power*, has been appointed

secretary and treasurer of the Technical Association of the Pulp and Paper Industry.

ELMER A. SMITH, member of the American Institute of Electric Engineers, has received notification of recent re-election to membership in Academie des Sciences, Toulon, France, "in recognition of distinguished work rendered to the electrical profession."

HERMAN MEZGER has recently joined Stone & Webster, Inc., as an engineer in the electrical division. Mr. Mezger received his education in Germany and was with the Brazilian section of the Foreign Department of the Allgemeine Elektrizitaets Gesellschaft, of Berlin. Since coming to this country, he has been with the Westinghouse Electric & Manufacturing Company at East Pittsburgh.

Business Notes

REEVES & SKINNER MACHINERY COMPANY, St. Louis and Kansas City, Mo., has been appointed agent in that section for the C. H. Wheeler Manufacturing Company, manufacturer of condensers, pumps, cooling towers, Philadelphia.

THE LINCOLN ELECTRIC COMPANY, Cleveland, announces the transfer of John Van Horne from Atlanta to Moline, Ill., where he will be located at 514½ Fifteenth St., covering the Tri-Cities, on the sale of "Linc-Weld" Motors and "Stable-Arc" Welders, operating under the direction of R. D. Malm, western manager at Chicago.

NORTHERN EQUIPMENT COMPANY, Erie, Pa., manufacturers of Copes feed water regulators, announce the appointment of the Hawkins-Hamilton Company, 502 West Seventh St., Charlotte, as representative for North Carolina. John H. Trescot is in charge of the Charlotte office. The Hawkins-Hamilton Company through its Richmond office is also representative for Copes regulators in Virginia.

THE GENERAL ELECTRIC COMPANY has announced the creation of a motor division of its industrial department through E. O. Shreve, manager of the department involved. The new division will have general supervision of all policies, prices, etc., concerning all motors handled by the General Electric Industrial Department. F. M. Kimball was appointed advisory manager, and J. E. N. Hume, manager, effective Jan. 1.

LINK-BELT COMPANY announces the appointment of four vice-presidents: George P. Torrence, with headquarters at Indianapolis, in general charge of Indianapolis operations and sales of Indianapolis plant products; George L. Morehead, Philadelphia, in charge of Eastern operations and sales; Frank B. Caldwell, in charge of the Chicago plant and sales offices tributary thereto, and W. C. Carter, in general charge of production at all plants, with headquarters at the general office of the company, 910 South Michigan Ave., Chicago.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Engineering Council, annual meeting will be held in Washington, D. C., Jan. 9-11; L. W. Wallace, executive secretary, 26 Jackson Place, N. W., Washington, D. C.

American Institute of Electrical Engineers, winter convention at New York City, Feb. 13-17, F. Hutchinson, secretary, 29 West 39th St., New York City; St. Louis Regional Meeting, District No. 7, March 7-9; Baltimore Regional Meeting, District No. 2, April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

American Society of Heating & Ventilating Engineers, hold general meeting at Hotel Pennsylvania in New York City, Jan. 23-26; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Association of Iron and Steel Electrical Engineers, annual convention at Hotel Stevens, Chicago, June 25-29.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National Association of Stationary Engineers, annual convention at Detroit, Sept. 11; Fred Raven, 417 South Dearborn St., Chicago.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

The National Marine Engineers' Beneficial Association, 53rd annual convention, will meet at the Lee House, 15th and L Streets, N. W., Washington, D. C., February 13-18. Albert L. Jones, Secretary-Treasurer, 313 Machinists Building, Washington, D. C.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Society Affairs

A. S. M. E. BUFFALO: January 17, Hotel Statler at 8:00 p.m. Subject: "The Arteries of Industry," motion picture films, National Tube Co. W. P. Wooldridge will lecture. There will also be shown a film on building New York's newest subway by the Dupont Company.

A.I.E.E., CLEVELAND SECTION meeting at Hotel Statler, 8 o'clock, Jan. 19; "Today's Science, Tomorrow's Engineering," by L. A. Hawkins, General Electric Company.

A.I.E.E., NEW YORK SECTION meeting at 29 West 39th St., New York City, Jan. 13, "Interconnection of Power Systems," Alex Dow, president of Detroit Edison Company, and Farley Osgood, consulting engineer.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Dec. 22, 1927
Navy Standard	New York	$2.25@$2.75
Kanawha	Hampton Roads	4.15@ 4.40
Smokeless	Cincinnati	2.25@ 2.50
Smokeless	Chicago	2.25@ 2.50
S. E. Kentucky	Chicago	1.40@ 1.60
Steam	Pittsburgh	1.60@ 1.90
Gas Slack	Pittsburgh	1.15
Big Seam	Birmingham	2.00@ 2.25
Anthracite (Gross Tons)		
Buckwheat	New York	$2.65@$3.35
Birdseye	New York	1.60@ 1.85

FUEL OIL

New York—Dec. 29, light oil, tank-car lots, 26 deg. Baumé, 5c. per gal.; 28 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Dec. 21, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4½c. per gal.; 38@40 deg., 5½c. per gal.

Pittsburgh — Dec. 19, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

Philadelphia — Dec. 27, 26@30 deg., $1.60@$1.66 per bbl.; 13@19 deg., $1.47 @$1.53 per bbl.; 22 plus, $1.63@$1.69 per bbl.; 27@30, $2.10@$2.16 per bbl.

Cincinnati — Dec. 27, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Dec. 17, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Dec. 27, tank-car lots, f.o.b., 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5⅜c. per gal.

Dallas—Dec. 17, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

Trade Catalogs

SEWAGE PUMPS—Yeomans Brothers Company, 1433 Dayton St., Chicago, has issued an illustrated bulletin describing the non-clogging sewage pumps manufactured by the company, for municipal and industrial plants.

VISE SUPPORT—A.F.K. Fountain Works, Milwaukee, Wis., has for distribution an illustrated folder of the A.F.K. vise work support, an accessory for any standard vise, and which is designed especially for jobs of eccentric shape or stock with very little gripping surface.

TRANSMISSION MACHINERY—Foote Bros. Gear & Machine Company, Chicago, has issued a new catalog, No. 68, on friction clutches and transmission machinery as manufactured by the A. Plamondon division of the company. Plamondon products include gearing and friction clutches for paper-mills, rubber-mills, tube-mills, cement-mills, rolling mills, stone quarries, turbines and waterwheels, sugar refineries, mining and coal-handling machinery, electric light plants, and cut gears and machine molded gears of all kinds. Complete specifications and prices are listed.

DIRECT CURRENT MOTORS AND MOTOR GENERATORS—Engberg's Electric & Mechanical Works, St. Joseph, Mich., in Bulletin 6023 treats of constant and adjustable speed, direct current, ball bearing, motors from 1 to 50 hp. In Bulletin 6025, the company describes Engberg motor generators from 1 to 37½ kw., giving also price list and export data.

THE KENNEDY VALVE MANUFACTURING COMPANY, Elmira, N. Y., in commemorating its fifty years of business, has published an interesting and handsomely illustrated brochure sketching the progress of company since its founding in 1877, for the manufacture of gate valves in limited quarters in a small building on Gold Street, New York City. To provide more adequate facilities the company moved in 1890 to Coxsackie, N. Y., and in 1907 its rapid development necessitated the building of a much larger plant at Almira, N. Y., where it removed, and added in 1921 an additional plant nearby for independent production of the malleable-iron pipe fittings lines which were added at that time. Throughout its half century of growth the Kennedy Valve Manufacturing Company has been under the guidance and ownership of Daniel Kennedy, founder of the business and still in active charge as president.

PORTABLE INSTRUMENTS — General Company in recent Bulletin GEA-158A treats of types DP-2 and P-3 portable instruments for direct current and alternating current. Ordering data for all instruments are given in tabulated form for convenience, also reproductions of actual scales, and two illustrations in color.

CO_2 AND DRAFT RECORDERS—The Hays Corporation, Michigan City, Ind., is distributing Catalog RL 27, which is descriptive of the Hays CO_2 and draft recorder, simplified and improved, with an analysis of operating conditions from a typical concentric chart. The improved Hays portable gas analyzer and Hays draft gages of pointer, inclined-tube, vernier and portable types also are given mention.

NEW PLANT CONSTRUCTION

Calif., Culver City—Loyola University, plans the construction of a college building near here. Estimated cost $1,000,000. T. F. Power, 2615 West 7th St., Los Angeles, is architect.

Calif., Los Angeles—Curlett & Beelman, Union Bank Bldg., Archts., are receiving bids for a 13 story office and loft building at 7th and Hill Sts. for Foreman & Clark, Metropolitan Bldg.

Calif., Los Angeles — Firestone Tire & Rubber Co., South Main St., Akron, O., awarded contract for first unit of factory including power house, etc., at Manchester Ave. and Alameda St., here, to J. V. McNeil Co., 5860 Avalon Blvd., Los Angeles. Estimated cost $700,000.

Calif., Los Angeles—L. Kaufman, c/o K. MacDonald, Jr., Spring-Arcade Bldg., Archt., is having plans prepared for a 12 story office and loft building on West 6th St. Estimated cost $650,000.

Calif., San Pedro—Union Ice Co., East 7th St., Los Angeles, awarded contract for the construction of a 135 ton ice and cold storage plant at 18th and Messa Sts. here, to Richards-Neustadt Co., 519 National Bank Bldg., Los Angeles. Estimated cost $103,000.

Calif., Signal Hill—City plans an election soon to vote $250,000 bonds for waterworks improvements including wells, reservoir, pumping plants, etc.

D. C., Washington—City Central Corp., R. A. Nordbloom, Pres., 30 Federal St., Boston, Mass., awarded contract for the construction of a hotel auditorium and convention hall at 15th and H Sts. N.W. here, to James A. Stewart Co. Inc., 17 East 42nd St., New York, N. Y. Estimated cost $4,000,000. Four electric elevators, etc. will be installed.

Ill., Chicago—W. C. Bannerman & Co., 77 West Washington St., awarded contract for masonry, etc. for a 24 story apartment building at 1430 Lake Shore Dr. Estimated cost $1,000,000. R. S. DeGoyler & Co., 307 North Michigan Ave., are architects.

Ill., Chicago—Belmont-Sheffield Trust & Savings Bank is having plans prepared for a 6 story bank and office building at Belmont and Sheffield Aves. Estimated cost $600,000. J. A. Nyden, 190 North Satte St., is architect.

Ill., Chicago—Rebori, Wentworth, Dewey & McCormick, 332 South Michigan Ave., Archts., will soon receive bids for a 13 story apartment building at Banks and Astor Sts. for Syndicate, c/o architects. Estimated cost $500,000.

Ill., Chicago—One Thousand One Hundred Seventeen North Dearborn Building Corp., c/o M. Bein, 64 West Randolph St., Archts., awarded contract for masonry, etc. for an 8 story apartment including refrigeration system, elevators, etc. Estimated cost $1,000,000.

Ill., Chicago—P. F. Reynolds, 6 South Dearborn St., awarded contract for a 22 story apartment at 1500 Lake Shore Drive to Turner Construction Co., 228 North La Salle St. Estimated cost $3,000,000. Central refrigeration plant, elevators, etc. will probably be installed.

Ill., Chicago—Sisters of Providence, 3107 West Van Buren St., awarded contract for a 4 story convent at Central Park Blvd. and Monroe St. to W. E. O'Neill Construction Co., 19 South La Salle St. Estimated cost $1,000,000.

Ill., Chicago—Syndicate, c/o Schmidt, Garden & Erickson, 104 South Michigan Ave., Archts., awarded contract for a 16 story office and stores building at 16-30 West Washington St. to Hegeman-Harris Co., 431 North Michigan Ave. Estimated cost $2,000,000.

Ill., Chicago—Woolworth Co., 608 North Michigan Ave., will soon award contract for 4 story stores building at 26-30 North State St. and 9-21 West Washington St. Estimated cost $2,000,000. W. W. Ahlschlager, 65 East Huron St., is architect.

Ill., Kenilworth—Village will receive bids until Jan. 16 for the construction of a water filtration plant and pumping station for waterworks. Estimated cost $50,000. Pearse, Greeley & Hansen, 6 North Michigan Ave., Chicago, are engineers.

Ind., Anderson—City plans the construction of an auxiliary light and power plant to serve large industries in South Anderson. Estimated cost $300,000.

Ind., Anderson—A. M. Strauss, 415 Cal-Wayne Bldg., Fort Wayne, Archt., is preparing preliminary plans for a 6 story hotel including steam heating system, elevators, etc. Estimated cost $700,000. Owner's name withheld.

Kan., Sterling—City is having plans prepared for extensions and improvements to power plant including new generating equipment, etc. Estimated cost $75,000. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., are engineers.

La., Monroe—S. D. Hunter, Commercial Bank Bldg., Shreveport, will soon receive bids for the construction of a 7 story office building here. Estimated cost $50,000.

Md., Baltimore—C. Hoffberger & Co., H. Hoffberger, Pres., Gay and Oliver Sts. had plans prepared for the construction of a cold storage plant at 541 East Monument St. Estimated cost $700,000. J. H. Wickersham, Appel Bldg., Lancaster, Pa., is engineer.

Mich., Detroit—Tuller Hotel Co., is having plans prepared for an 18 story commercial building including steam heating and ventilation systems, boilers, elevators, etc. on Bagley Ave. J. F. Hughes Co., Dayton, O., is architect.

Mo., Kansas City—Kansas City Public Service Co., 15th St. and Grand Ave., plans to expend $3,850,000 for the construction of buildings, extensions of lines, etc.

Mo., Kansas City—Kansas City Power & Light Co., 14th and Grand Ave., plans additions to power and light plant; also extensions and improvements to transmission lines, etc. during 1928. Estimated cost $2,500,000.

Mo., St. Louis — Syndicate, c/o J. L. Bowling, 1198 Arcade Bldg., Archt., is having preliminary plans prepared for an 8 story apartment including steam heating system, etc., at 4200 Lindell Blvd. Estimated cost $500,000.

Mo., Springfield—Empire District Electric Co., c/o H. L. Doherty, 66 Wall St., New York, N. Y., will build a hydro-electric plant and dam, 175 ft. high at Lake Taneycomo on White River near here including sub-stations, four 37,000 kw. generators, transmission lines, etc. Estimated cost approximately $25,000,000. Private plans. Work will be done by day labor.

N. Y., New York—Metropolitan Coliseum Inc., H. J. Fugazy, Pres., 1599 Broadway, had plans prepared for an assembly hall at 746 13th Ave. Estimated cost $5,000,000. T. W. Lamb, 644 8th Ave., is architect.

N. Y., New York—Randson Realty Co., c/o Harry & Sidney Rodwin, 475 5th Ave., plans the construction of a 22 story hotel at 64th St. between Fifth and Madison Aves. Estimated cost $1,400,000. Architect not announced.

N. Y., New York — Seventy Nine West One Hundred Sixty Second St. Corp., c/o H. Ginsberg, 220 East 42nd St., Archt., is having plans prepared for a 6 story apartment building on Woodycrest Ave. and 162nd St. Estimated cost $800,000.

N. Y., New York — Tudor City-Fifth Unit Inc., 350 Madison Ave., will build a 10 story apartment building at 315 East 43rd St. Estimated cost $850,000. F. F. French, 350 Madison Ave., is architect. Work will be done by separate contracts.

N. Y., New York—H. H. & P. Uris, 50 East 42nd St., plans the construction of a theatre and stores building at 21 West 14th St. Estimated cost $3,000,000. Architect not selected.

O., Cleveland—The Cleveland Electric Illuminating Co., R. Lindsay, Pres., Illuminating Bldg., awarded contract for a switch and control station on West 95th St., to S. W. Emerson Co., 1836 Euclid Ave. Estimated cost $100,000.

O., Dayton — Bd. of Control will soon award contract for the construction of a boiler room for city garbage reduction plant. Estimated cost $40,000.

O., Mt. Washington—St. Gregory's Seminary, awarded contract for the construction of a 4 story school at Ohio Park to M. J. Roche Construction Co., Southern Bank Bldg., Cincinnati. Estimated cost $1,500,000.

Okla., Oklahoma City — Athletic Club plans the construction of a 12 story office buliding, including elevators, etc. Estimated cost $600,000. Layton, Hicks, Forsythe, Braniff Bldg., are architects.

Ore., Portland—Columbia University, E. Donahue, Pres., is having preliminary sketches made for a 10 story school. Estimated cost $4,000,000. Jacobberger Smith, Railway Exchange Bldg., is archt.

Tex., Amarillo — Atchinson, Topeka & Santa Fe R.R., 80 East Jackson Blvd., Chicago, Ill., will receive bids after Jan. 1 for a 14 story office building, including steam heating system, boilers, elevators, etc. at 9th and Polk Sts. Estimated cost $1,000,000. C. F. Felt, is chief engineer.

Tex., Del Rio—Central Power & Light Co., Frost Bldg., San Antonio, will build a power dam on Devils River, near here, by day labor. Estimated cost $1,000,000. Private plans.

Tex., McAllen — Hidalgo County Water Improvement Dist. 6, McAllen, plans to irrigate 25,000 acres of land in Goodwin tract near here to include pumping plant, etc. Estimated cost $1,600,000.

Tex., Menard—City, c/o R. M. Heyman, mayor, will soon award contract for waterworks improvements including pump house, three horizontal electrically driven pumping units, etc. Koch & Fowler, 801 Central Bank Bldg., Dallas, are engineers.

Tex., Olmito—A. Parker Securities Co., c/o A. F. Parker, Pres., will build a waterworks system including reservoir, pumping and filtration plants, etc. Estimated cost $25,000. Private plans.

Tex., Port Arthur—Owner, c/o R. L. Drake, Chn. Hotel Committee of Chamber of Commerce, plans the construction of a 10 story hotel. Estimated cost $700,000.

Tex., Raymondsville — Texas Central Power Co., Frost Bldg., San Antonio, plans the construction of a cold storage and refrigeration plant here. Estimated cost $100,000. Work will probably be done by day labor. Machinery and equipment will be required.

Tex., San Antonio—Hilltop Hotel Co., H. C. Wood, Travis Bldg., plans the construction of an 8 story hotel including refrigeration system, boilers, elevators, swimming pool, etc. Estimated cost $1,500,000. Herff & Jones, San Antonio Loan & Trust Bldg., are architects.

Tex., San Antonio—Texas Ice Co., A. J. Zilker, Fredericksburg Rd., plans the construction of a 60-ton ice plant. Estimated cost complete $100,000. Private plans. Machinery and equipment will be required.

Tex., Temple—Atchison, Topeka & Santa Fe Ry. System, 80 East Jackson Blvd., Chicago, Ill., awarded contract for the construction of an automatic electric sand handling and drying plant, capacity 540 ton wet sand in steel pocket, to Ogle Construction Co., 28 East Jackson Blvd., Chicago, Ill. Est. cost $125,000.

Tex., Texas City—Texas Gulf Power Co., will build a power plant. Estimated cost $300,000. Private plans.

Vt., Glen Carvers Falls—Vermont Hydro-Electric Co., awarded contract for the construction of a hydro-electric plant to Morton C. Tuttle Co., Park Sq. Bldg., Moston, Mass.

Wash., Seattle—Hillcrest Investment Co., c/o C. F. Mahon, Lyon Bldg., awarded contract for a 10 story hotel at Fourth and Spring Sts., to A. D. Belanger, Everett. Estimated cost $500,000.

Wash., Seattle—Bd. of Public Works, awarded contract for electrical machinery for unit 6 of Cedar Falls hydro-electric power project, including 18,000 hp. turbine and 325 hp. water wheel to Pelton Waterwheel Co., 2929 19th St., San Francisco, Calif., $65,270., also three 5,000 kva. transformers to General Electric Co., Colman Bldg., Seattle, Wash., $24,885. Other contracts to be awarded later.

Wis., West Allis—Randon Lake Ice Co., 68 Locust St., Milwaukee, awarded contract for the construction of an ice plant to K. W. Construction Co., 589 Mabbett St., Milwaukee.

Ont., Hamilton—Canadian National Railways, New Union Station, Toronto, plans the construction of a passenger terminal including steam heating system, etc. here. Estimated cost $1,000,000. T. T. Irving, Toronto, Ont. is district engineer.

Ont., Saulte Ste Marie—Public Utilities Comn., City Hall, plans the construction of a hydro-electric development, 12,000 hp. capacity on the St. Marys River to include a dam, power house, water turbines, generators, transformers, switching equipment, etc. Estimated cost $2,005,065.

Ont., Stratford—Kroehler Mfg. Co., plans the installation of a 500 hp. steam boiler plant in connection with furniture factory. Estimated cost $100,000 to $200,000. Private plans.

Ont., Toronto—Belle Ewart Ice Co., 3350 Gerrard St. E., awarded contract for the construction of an artificial ice storage plant and engine room etc. to J. A. Wickett Ltd., 16 Saulter St. Estimated cost $50,000.

Equipment Wanted

Boiler Plant Equipment—Waldorf Paper Products Co., Myrtle and Pillsbury Aves., St. Paul, Minn., will receive bids until Jan. 12 for furnishing and installing boiler plant equipment including boilers, steam turbines, generators, switchboards, etc.

Coal Stoking and Pulverizing Machinery, Etc.—Malleable Iron Works, G. E. Bean, Pres., New Britain, Conn., plans the installation of coal stoking and pulverizing machinery, also annealing and cooling conveying machinery and oven equipment for hot mill, estimated cost $200,000.

Generator, Turbine, Exciter, Etc.—City of Milton, Ore., F. A. Fullerton, Bus Mgr., will receive bids until Jan. 23 for one 1,000 kw. electric generator direct connected to hydraulic turbine and exciter together with governor, gate valves, etc.

Pump—E. A. Shuman, Dir. of Public Service, Fostoria, O., will receive bids until Jan. 18 for furnishing and installing a 3 m.g.p.d. cross compound pump for proposed waterworks improvements.

Pump, Etc.—Village of Oak Park Village, Mich., plans to purchase pump, etc. for proposed waterworks system. Estimated cost $300,000.

Pump and Motor—City of Great Falls, Mont., will receive bids until Jan. 9 for one 2,800 g.p.m. centrifugal pump with synchronous motor and starting equipment.

Pumps—Ing. C. M. Sigmund, Brno, Wawrova 10, Czechoslovakia, prices and catalogs on water jet pumps.

Regulators, Transformers, Motor Generator Set, Etc.—Bd. of Purchase, W. H. Duffy, Pres., City Hall, Columbus, O., will receive bids until Jan. 5 for six 40 kw. street regulators, two 40 kw. feeder regulators, two 0 kw. feeder regulators, three 400 kw. transformers, two 5 kw. transformers, one automatic motor generator set for proposed electric sub-station on Wheatland Ave. Estimated cost $15,000.

Turbine, Pumping Equipment, Transformers, Etc.—Central Power & Light Co., E. B. Neiswanger, Frost Bldg., San Antonio, Tex., plans to purchase and install one 3,300 hp. turbine and additional unit to central power plant, pumping equipment for waterworks and transformers. $328,000 appropriated.

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